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ABSTRACT

This guide establishes statewide networking standards and addresses key issues regarding network implementation. It is designed to be a framework for construction of access to the global electronic highway for all California public schools. An in-depth view of the major areas that must be considered when schools are developing their technology plans is provided. Part 1 provides background on the state's educational networking efforts. Part 2, "Making the Case," outlines many of the immediate benefits of networking and provides examples of ways to achieve maximum return on investment in network technology. Part 3, "The Technical Plan," presents detailed design parameters and planning guidelines. Part 4 addresses "Training the Staff," with approaches to staff development and suggested resources to help in implementing training programs. Six appendices are included to improve the reader's understanding of network planning that focus on progress reports, selecting connections, internet access, resources and policies, and future technology. Each chapter is labeled with an indicator of its technical difficulty. Eighteen figures and three tables illustrate the discussion. (Contains 29 references.) (SLD)

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Building the Future

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K–12 *Building* Network *the* Technology *Future* Planning Guide

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A partial list of other educational resources available from the Department appears on pages 177–78. In addition, a 68-page illustrated *Publications Catalog* and its supplement, which describe the content of educational resources available from the Department, can be obtained without charge by writing to the address given above or by calling the Sales Unit at (916) 445-1260.

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Preface

It is with great pleasure that we introduce to you the *K–12 Network Technology Planning Guide* (the *Guide*). In this *Guide* we have set statewide networking standards and addressed key issues regarding network implementation. It is our hope that this document will serve as the framework for construction of access to the global electronic highway for all California public schools and will provide all our schools an incentive and a valuable tool for moving forward into the information age.

Throughout California we have been able to identify a small number of schools, districts, and county offices of education that already have embarked on integrating telecommunications across their curriculum, administration, and/or professional development. The rewards they describe for their efforts in this area are very similar to the incentives described in a 1993 report from the Bank Street College of Education's Center for Technology in Education:

"Communicating with other educators, accessing information, and combating professional isolation are the most highly rated incentives for using telecommunications as a professional resource. The most highly rated incentives for using telecommunications with students include expanding students' awareness about the world, accessing information, and increasing students' inquiry-based and analytical skills."

However, like the Bank Street researchers, our teachers, administrators, and students have discovered that the ultimate benefits of networking only will be realized when planning for the integration of telecommunications into instruction and administration is careful and comprehensive. We in the Department of Education have worked with numerous educational and technical advisors for many months to undertake for you much of that necessary planning. Of course, our work does not eliminate the need for your own site planning, but we believe that with this document in hand you will be well prepared to begin, or elevate, the discussions at your site regarding your network planning. In addition, attention to the recommendations in this *Guide* will help ensure that California implements a networking infrastructure that supports equity of access, efficient statewide communication, and provides incentives for professional collaboration among all educators in California public schools.

This *Guide* provides a standard framework for the technical aspects of the network while allowing vast flexibility to individual sites as to how they will use the tools of the network once they become available. The framework is based upon current and available technologies and incorporates design strategies which will allow us all to take advantage of new technologies as they emerge.

We are proud to deliver to you the information contained in this *Guide* and anticipate a time when we can all reap the benefits of the exciting opportunities inherent in global networking.

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Acknowledgments

Improving California's educational system is a monumental goal shared by many. The California Department of Education created the K–12 Network Planning Office in order to address one very important component of this goal—the integration of network technology into schools.

This *K–12 Network Technology Planning Guide* (the *Guide*), the first publication from the K–12 Network Planning Unit, is designed to assist all schools wishing to gain access to the vast and exciting resources available via networks. The California Department of Education (CDE) wishes to thank all those who have contributed to the *Guide*.

The *Guide* is the result of a collaborative effort involving dozens of individuals and schools. Carole Teach of the CDE's Network Planning and Technology Unit managed every aspect of the *Guide's* creation. Under her guidance leading experts were identified and hundreds of pieces of data were collected, interpreted, prioritized and integrated into a comprehensive picture of a good network system. The *Guide* is the only publication of its kind in the nation.

Our gratitude is extended to the members of the K–12 Network Technical Planning Committee (TPC) for their dedication, expertise, and extraordinary devotion to the improvement of education. The members are:

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*Andrea McCurdy, Technical Consultant, Autodesk Foundation and NASA

*Denis Newman, Bolt Beranek and Newman Inc.

*Elizabeth Share, Vice-President, Autodesk Foundation

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Lastly, CDE extends its appreciation to all individuals, especially the teachers, educational technology directors, and mentor teachers, whose pioneering work with networks provided the inspiration for this guide. Their ideas, experiences, and dreams are the foundation of this effort.

*The CDE especially recognizes those individuals who gave their time, energy and creativity in writing, reviewing, and editing the *Guide*. It is due to their efforts that this document was written. Our special thanks to David Wasley for writing the Technical Model for School Networks and guiding so many of the various technical aspects of the document.

Executive Summary

Network Technology — a Necessity

California is home to one of the largest public school systems in the nation and to some of the most successful high technology industries in the world. These industries require a well educated workforce for the full range of jobs that they offer and look to the California public schools to educate their future employees in matters both academic and social. Both the public schools and California industries are committed to finding ways to ensure that California is a leader in the global economy of the 21st century and together are exploring new ways to use technology to enrich classrooms as well as the administration of the public school system.

One of the most exciting new information technologies that educators and businesses agree can powerfully improve education in the state is modern, interactive, high-capacity communications systems. Such systems have the potential to bring up-to-date information directly to the learning environment in a variety of electronic formats and educational contexts. When this resource is fully developed, schools will no longer suffer shortages of curricula and reference materials, nor will traditional budget constraints dictate the quality or amount of material students and teachers can access. Teachers and school administrators will find themselves able to work in new ways with colleagues across the state and nation on a daily basis, rather than on the rare occasions they actually meet for conferences. Even the classroom itself will expand as the physical constraint of place gives way to the interactive communications highway.

In *The Master Plan for Educational Technology*, the California Planning Commission for Educational Technology states that "technology will enhance student's learning; increase the intellectual productivity of faculty; and contribute to the management efficiency of administrators and staff through the use of instructional and information technologies." In 1992, the California Legislature passed the Educational Technology Act (SB 1510) authorizing the Education Council for Technology in Learning and the California Department of Education to plan for much greater use of computing and communications technology in California schools. Realizing this tremendous potential will take time, funding, and hard work; however, some schools already use telecommunications, and the benefits are proving to be very compelling (see Part II–Making the Case and Appendix A–Networking Progress Reports).

The *K–12 Network Technology Planning Guide* (Guide) is consistent with The Task Force on Education Network Technology and its report to the National Education Goals Panel, "Achieving Educational Excellence by Increasing Access to Knowledge." In that report the task force states, "Network technology is a set of tools and services that enables educators, students, and the public to use computer and telecommunication links to share and access information and other resources to achieve systemic reform in education." Systemic reform will occur because:

- "Internetworked communications restructure relationships among educators, learners, and knowledge and information and promises a systemic acceleration of the pace of educational change.

- For teachers, it means: 1) the chance to develop a professional community with other educators; 2) technical assistance in achieving a standards-based curriculum; and 3) an expansion of their pedagogical repertoires to serve students' diverse learning styles.
- For students, it means: 1) more learning resources, more readily available; 2) information on demand and immediate feedback; and 3) a context for learning that both engages and empowers them.
- For the larger society, it means: 1) home and workplace connections with schools; 2) learning for life; 3) technological literacy for economic progress; and 4) the communication and exchange essential to democratic living."

The development of a *long-term* plan for a communications technology infrastructure is the logical first step for any school desiring the systemic reform that will produce the benefits just described. A long-term plan is essential so that the infrastucture which is affordable to build today provides a foundation which will accommodate the exciting, emerging, and new technologies of tomorrow as well.

The intention of this guide is to facilitate the development of this plan so that the potential benefits of network technology to the schools, students, educators and the community become real benefits. We hope that the guide will be the beginning of a movement across California, initiating appropriate network technology planning, information and idea sharing, and mutual support among schools, districts, county offices of education, and the California Department of Education.

Finally, we intend that the guide foster collaboration with higher education, industry, local communities, and other governmental agencies to prepare for a future where all are participants in the National Information Infrastructure.

Introduction

Purpose of the Guide

We are living in a world where information technology is increasingly driving change. We see daily reminders in the media (newspapers, magazines, television), in the workplace, and in our daily lives about the Information Super Highway. Educators wonder what it all means and can it really do something to reform education.

The *K–12 Network Technology Planning Guide* is intended to help school administrators, teachers, and technology directors sort through the confusion and develop a base for understanding technical issues relating to network planning. The *Guide* provides an in-depth view of the major areas which must be considered when schools are developing their technology plans. It lays the foundation for the planning that needs to occur. For this reason, a consultant or technical specialist is recommended to configure a network that fits the school's environment and addresses specific needs and requirements.

Background

The *Guide* was initiated by the California Department of Education's (CDE) Technical Planning Committee (TPC), in response to requests from the K–12 education community across California. Bringing awareness and knowledge of network technology to educators was a commitment of the committee because it was believed that communications networking could restructure and enhance teaching and learning in California's classrooms. This direction is consistent with a report released by the National Education Goals Panel, "Achieving Educational Excellence by Increasing Access to Knowledge," July 1993, which states:

> The pre-k/12 community must be awakened to the enriched educational opportunities afforded by internet-worked communications and information access, and be open to the challenge and possibilities of this emerging technology frontier.

With this commitment in mind, the Technical Planning Committee, composed of representatives from K–12 districts, county offices of education, higher education, network providers and the CDE, began meeting to discuss issues of networked communications technology among schools linked via the Internet (the network of networks which is the foundation for the Information Super Highway. See Part I, Chapter 1). The TPC defined as its mission:

> **To plan and coordinate the internetworking of all California K–12 schools in a technically sound, cost-effective architecture enabling schools to participate equitably in the emerging National Research and Education Network (NREN) in support of instruction, school administration, and teacher education.**
>
> (May 1992)

Members of the committee met with educators across the state, including superintendents, teachers, information and educational technology directors, and students to try to better understand the real issues schools face as they deal with technology, and to better determine what the committee could do to promote and address effective network communications technology. As the TPC visited

schools and district offices it became apparent that there was replication of research and planning and the struggle to unravel the issues of network technology. Each school or district office seemed to start at "ground zero" without having the benefit of what others had already learned. There was very little sharing with one another of insights gained, or plans made by a school, district, or county office of education.

From these meetings, three factors that schools and districts most often stated as predominant deterrents to developing communications network plans became apparent: 1) lack of leadership, 2) lack of funding, and 3) lack of technical support.

On the other hand, committee members met with a number of districts, county offices of education and schools that had made a commitment to technology planning and were restructuring and shifting funds to make networked communication a reality in their schools. Invariably, those we spoke to asked that the CDE take a leadership role and pave the way for the planning and development of communications networking.

In order to address this challenge, one of the first goals of the Technical Planning Committee was to define the internetworking standards for communications, which the committee determined must be based on the Internet protocols (explained in the letter at the end of this Introduction). The CDE adopted the Internet protocols and recommended this approach in a letter sent to all districts and county offices of education in October 1993. A second goal was to develop written information that would assist schools and districts in understanding requirements for developing network technology plans.

As the TPC discussed these issues, the *K–12 Network Technology Planning Guide* evolved. It was determined that presenting only the technical aspects of building networks would address only a small part of the issue. In order to set the stage for schools and districts to realize success with technology, it became equally important to stress staff development and technical support. The heart of the document then became three-pronged: 1) presenting the technical network model (Part III), 2) addressing the training (staff development) requirements (Part IV), and 3) presenting technical network support issues (Part III). As indicated by the conclusions of the "Telecommunications and K–12 Educators: Findings from a National Survey" (Honey and Henriques, 1993), "In order for telecommunications to become a widely used educational resource, administrators and policy makers must implement the following:

- teacher training and support;
- school and district planning for integration of telecommunications into instruction and administration;
- time in the school schedule for professional and student learning activities;
- effective assessment measures;
- financial support;
- multiple phone lines or local area networks in schools."

It was further determined that the technical network model would be designed for scalability and interoperability. This means the network that is put in place in the school must be designed to handle advances in technology without being replaced and can interface with various types of communications networks, using a common protocol. Based on this design, schools will be positioned to take advantage of emerging technologies and telecommunications planning for development of the Golden State Education Network (GSEN)[1] and its fit with the Information Super Highway — the National Information Infrastructure.

[1] The title given to the education and industry effort to plan an internetworked environment for communication among all sectors of education.

The committee also determined that to be truly effective the *Guide* needed to address other critical issues, so that educators would gain the fullest possible insight into developing a truly vital plan for implementing network technology within their environment. These issues are defined in more detail in the following section on The Structure of the *Guide*.

The National Education Goals Panel describes "The Desirability of Using Network Technology to Achieve Educational Excellence" by presenting four "major rationales for deployment and utilization:

I. Support and Accelerate Systemic Change for Educational Excellence;
II. Reconstruct and Improve Teaching;
III. Expand and Enrich Learning Opportunities;
IV. Link Schools and Society to Improve Economic Productivity and Encourage Lifelong Learning."

"Internetworked communications and access to information is a rich curricular resource and an invitation to inquiry and exchange. This medium offers a dramatically decentralized and essentially democratic learning environment. Abundant resources available on-line suggest new ways of accessing information, generating and disseminating knowledge, working independently and collaboratively (unbounded by the physical limitations of place and time or the personal characteristics of participants). Pervasive real-time communication creates a new context for thinking and interacting and presents unprecedented pedagogic opportunities for exchanging ideas and information and creating 'virtual' labs and classrooms and enriched teaching and learning."

It is because of these larger benefits that the *Guide* was developed, and it is our sincere hope that, given commitment and effort, we can all have a part in changing education in California.

Structure of the Guide

The *Guide* is designed to address more than the technical issues of planning and designing network technology. As will be seen, there is a breadth of information that will assist readers to understand the issues related to network technology.

Part I–The Background introduces you to the emerging role of networks and networking in the state and the nation.

Part II–Making the Case outlines many of the immediate benefits of networking and provides examples of ways in which a school or district can achieve maximum return on its investments in network technology.

Part III–The Technical Plan presents sufficiently detailed design parameters and planning guidelines to enable a school or district to work with experts to implement a cost effective, high quality network which will be compatible with statewide information network services. The Technical Model is intended to address issues of expandable and upgradable systems which anticipate changes as technology improves and user-demand increases.

Part IV–Training the Staff suggests approaches to providing staff development, and identifies some of the resources available to help schools and districts implement training programs.

Appendices A through F are intended to enhance the reader's understanding of network planning, including:

Appendix A–Networking Progress Reports describes how a number of schools, districts and county offices of education are dealing with network technology;

Appendix B–Selecting Dialup Connections explains how to begin communication and access to resources prior to the installation of the local area network and direct Internet access;

Appendix C–Internet Access Providers identifies costs and services of the various

Internet service providers, including dialup and leased line services;

Appendix D–Networking Resources lists readily available resources, books, journal articles, on-line documents about networking and planning;

Appendix E–Acceptable Use Policies describes issues that should be addressed as schools make network access available to students. This appendix also includes examples of appropriate use policies adopted by schools already using the Internet.

Appendix F–Future Communications Technologies provides options to consider as technology advances.

The Glossary will help the reader understand any unfamiliar terms.

How to Use the Guide

To help readers through the myriad of information contained in the *Guide* and to help zero in on specific areas of interest, a navigator has been designed to indicate the degree of technical difficulty. The navigator appears in the top right corner of each chapter, with a hand indicating a scale of one to five, with one representing general knowledge, and five representing most technical information, as shown below.

Date: October 22, 1993

To: County and District Superintendents of Schools
Attention: Business Managers
Information Technology Directors

From: William D. Dawson
Acting State Superintendent of Public Instruction

Subject: **Recommended communications network protocols**

In 1991, the California Department of Education published the *Strategic Plan for Information Technology*, which outlines a vision for the use of technology to enrich and enhance California's public school system. In 1992, the California Planning Commission for Educational Technology submitted *The California Master Plan for Educational Technology* to the Governor, the Legislature, the State Board of Education, and the Superintendent of Public Instruction. Both reports recommended that the state establish a voice, video, and data network of networks to support learning and educational administration. The development of the network infrastructure comes under the auspices of the Golden State Education Network as supported by the Industry and Education Councils for Technology in Learning.

To advance the recommendations in the reports, the Department adopted the Internet standard protocols for communications networking and recommends that school districts and county offices of education include the same standard in their technology planning. The rationale and benefits of this strategy are explained in the attached "The Internet Communications Standard."

Please keep in mind that you do not need to replace your existing network communications protocols. Internet protocols can coexist successfully with other protocols within your network, as exemplified by numerous existing multiprotocol environments. For new networks and new applications, consider the use of Internet protocols so that eventually all schools will be able to participate in the statewide communications network infrastructure.

The Department has been working with an advisory group, the Technical Planning Committee, to develop a framework for planning network infrastructure within districts and county offices of education. This information will be documented in the *K–12 Network Technology Planning Guide*, which will be distributed to you later this year.

Please share this information with others in your school district or county office who are developing communications systems. Planning today to become part of the larger statewide network will position schools and districts to take advantage of statewide, national, and global communications opportunities tomorrow.

If you have any questions regarding the intent of this memorandum, please contact Carole Teach at (916) 654-9662.

WDD:ct
Attachment

Attachment

THE INTERNET COMMUNICATIONS STANDARD

The California Department of Education has adopted the Internet protocols, composed of the Transmission Control Protocol/Internet Protocol (TCP/IP) suite, for statewide communications and will be using the Internet for electronic communications (electronic mail, file transfer, etc.) with school districts and county offices of education in the state. For local educational agencies (LEAs) with existing networks and for those that will be establishing them, the Department is recommending that LEAs connect to the Internet through a local point of presence, e.g., an Internet Service Provider (BARRNet, CSUNet, CERFnet).

Rationale for the Use of Internet Protocols

Ubiquity–TCP/IP is available on most, if not all, of the computing platforms likely to be important for instructional or administrative purposes. TCP/IP is available for the IBM compatible personal computers (PCs) running DOS or Windows and all versions of the Apple MacIntosh. TCP/IP is standard on all UNIX-based systems and workstations produced by companies such as Sun Microsystems, Hewlett-Packard, Digital Equipment Corporation, and IBM. Mainframe computer manufacturers such as IBM and Unisys (Burroughs) now support TCP/IP as standard program product offerings for all of their traditional mainframe products.

Applications–TCP/IP supports many applications, including, but not limited to, electronic mail, file transfer, interactive remote host access, database access, file sharing, and access to networked information resources. Programming and development expertise is available from a wide variety of sources.

Flexibility–TCP/IP is flexible, and new data transport requirements can be incorporated easily. It can accommodate educational and administrative applications equally well so that one set of network cabling and one communications system may be used in both the classroom and the office.

Simplicity–TCP/IP is simple enough to run on low-end computing platforms, such as the Apple MacIntosh and PCs, while still providing efficient support for large minicomputer and mainframe computing platforms. TCP/IP benefits from over twenty years of refinement that has resulted in a large and technically sophisticated environment.

Capacity–TCP/IP supports local area network and wide area network services within the entire range of network data rates available today, from dial-up model speeds to gigabit speed experimental networks. Communications can occur reliably among machines across this entire range of speeds.

Coexistence–TCP/IP can coexist successfully with other networking architectures. It is likely that offices and classrooms that already have networks may be using something other than TCP/IP. Networks of Apple Macintosh computers will probably be using AppleTalk; networks of PCs may be using Novell's NetWare. Large school districts may be using IBM's System Network Architecture (SNA) in data processing facilities. None of these other protocols provide broad connectiv-

ity on a global scale. Network technology vendors have recognized the ubiquity of TCP/IP and provide several means of building TCP/IP-based networks that also transport AppleTalk, NetWare, and SNA messages locally.

Multimedia–In addition to supporting standard data transport capabilities used by traditional data processing applications, TCP/IP can support voice and video necessary for teleconferencing and multimedia applications.

Compatibility–All of the campus and universitywide networks of the California State University and the University of California systems use TCP/IP for their primary communications services. In addition, thousands of commercial and governmental organizations throughout the state and nation use these protocols. Many K–12 school districts and county offices of education have installed districtwide TCP/IP networks and many more installations are planned.

NREN–The High Performance Computing Act of 1991 and the Information Infrastructure and Technology Act of 1992 provide the foundation for building a national telecommunications infrastructure in support of education and research. The National Research and Education Network (NREN) will be based on Internet technology. The current Internet constitutes a global electronic highway that interconnects over one million computers and enables tens of millions of students, teachers, and researchers to communicate daily, exchange ideas, share data, and collaborate on a wide variety of projects.

Internetworking Benefits

The Internet is already being used by a number of schools in California, as demonstrated by the following examples:

- Teachers and students at the Woodside Elementary School in Woodside and the James Flood Elementary School in Palo Alto are using the Internet to integrate telecommunications-based resources into the curriculum. This collaborative project titled "Net Age" will "build bridges between economically and culturally diverse students to improve the academic achievement of all students, to reduce the alarmingly high dropout rate for students of the East Palo Alto area, and to prepare all of the students for life and work in the information age."
- Students at Rancho Verde High School in Moreno Valley are using resources available on the Internet to conduct research and complete calculus assignments.
- Students a. Davis Senior High School in Davis are accessing the San Diego Supercomputer Center over the Internet and turning time-sequenced drawings into animated three-dimensional movies.
- The Department is working with representatives from school districts and county offices of education to pilot an application to transmit student records electronically over the Internet. A demonstration project is planned for 1993-94 in five counties and several school districts.
- The Department's Research, Evaluation, and Technology Division is participating in a National Science Foundation funded project titled "The National School Network Testbed." Through the Testbed, a UNIX server has been installed in

the Department and will be developed initially for easy access to Departmental information over the Internet.

- These and many more uses of the Internet will enrich and enhance California's school system.

The Technical Planning Committee

The Department has received valuable ideas and support from a team of telecommunications experts representing school districts, county offices of education, and institutions of higher education. This team, known as the Technical Planning Committee, has met regularly since June 1992 to plan and coordinate the internetworking of all California public schools, using a technically sound and cost-effective architecture that will enable schools to participate equitably in the statewide network, the global Internet, and the emerging National Research and Education Network.

The Committee recognized that for statewide communication to occur among local educational agencies and the Department, local network infrastructures must be established first. Many districts already have local area networks in place; others are in the planning stages or are unsure how to proceed. To address the need for a compatible infrastructure, the Committee has developed the *K–12 Network Technology Planning Guide*, which the Department will publish and distribute to local school districts and county offices during the 1993-94 school year. The *K–12 Network Technology Planning Guide* will help local educational agencies in their technology and network planning and will identify critical network infrastructure issues. The Guide will provide technical models, training and support information, case studies of networking implementations, and funding and security recommendations.

For information call Carole Teach at (916) 654-9662.

PART

THE BACKGROUND

Chapter 1

Networks and Networking

Chapter 2

K–12 Networking:
A National and Statewide Perspective

This first section of the *K–12 Network Technology Planning Guide* introduces you to the emerging role of networks and networking in the state and the nation.

Chapter 1

Networks and Networking

The document that you are reading uses the terms network and networking throughout. Therefore, it is important that we share a common definition and understanding of what is meant by these words.

What Is a Network?

"Network" is a very old word referring to a web of interconnected ropes. Its use has been extended to describe a wide variety of interconnected entities such as a network of roads or even a network of friends. Most recently, the term network has been applied to a collection of computers interconnected so that they can communicate among one another. A somewhat more technical definition of a network is as follows:

NETWORK:
A shared communications system supporting digital communication among attached computers.

Figure 1-1 illustrates a network user's view of the communications system. Although this illustration in extremely simple, a modern data communications network is a complex system of communications media and electronic equipment that transports digital information from one place to another. The scope of a network can be as small as several computers in a room or as large as millions of computers all over the world — or both.

A small network serving a collection of computers in the same general location is referred to as a local area network or LAN. If the computers are more dispersed, for example in different buildings around a city or state, the network is referred to as a wide area network or WAN. Internetworking describes a model in which LANs are interconnected, often by means of WANs.

It is important to note that the definition of a network used in this document does not include any particular function or application. A network is the utility that enables communication — much like the telephone system. If a network is designed properly, it can support many kinds of applications, and these applications can change and grow over time.

What Can Be Done by Using a Network?

Computer networks were first developed in the 1960's when there came to be more than a few computers in the world. Computer users at that time who wished to

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share data or computer programs were required to copy their information onto computer tape or other machine-readable media, then send that media via postal mail to their colleagues. This process took considerable time and expense, especially if information had to be sent to several individuals or the process had to be repeated frequently. Computer users felt it would be useful if they could send data directly from one computer to another electronically. Thus were planted the seeds of computer networking.

Today, there are millions of computers in the world and computer networks support a wide variety of applications, many of which are described in detail later in this document. Common application areas include:

- Person to person message systems such as electronic mail, electronic bulletin boards, and "chat" systems,
- Transfer of large blocks of data from computer to computer,
- Access to specialized or expensive computing machinery such as supercomputers,
- Access to information resources that are maintained at remote locations or are too large to be stored on personal computers,
- Sharing of expensive resources, such as color printers or scanners,
- Limited forms of audio and video conferencing.

Not all networks support all of these capabilities. However, the network technology that is described in this document was chosen partly because it does, and it can be adapted to new areas as well.

What Are the Elements of a Computer Network?

Networks are comprised of many elements, all of which must be designed to work together to form a reliable communications system. A typical network system can be divided into 3 main types of components: the physical media, active electronic components, and the network protocols. In general, each of these elements can be defined separately and can

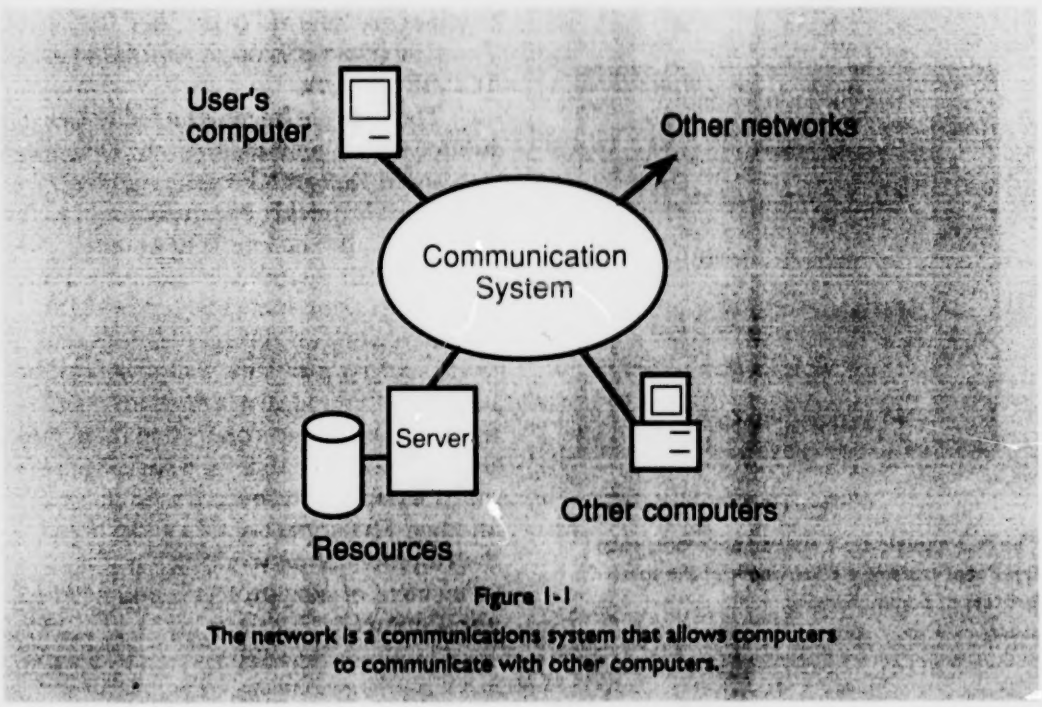

Figure 1-1
The network is a communications system that allows computers to communicate with other computers.

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be made to work together. However, the most critical choice to be made in designing a data communications network is the choice of network protocols.

A protocol is an agreed-upon set of procedures intended to describe how 2 or more entities interact to achieve a goal. A computer network protocol is a detailed definition of how 2 or more computers exchange information in a way that all can understand. Thus it is really the network protocols that define a shared communications system supporting digital communication among attached computers.

In order to help our understanding of network protocols, the International Standards Organization (ISO) has defined a conceptual model, often referred to as "the seven-layer model" for computer networking as represented in Figure 1-2. This model separates the data communication aspects of networking from the particular applications that such communications might support. The critical set of protocols for the purposes of this document are those that support basic data transmission among computers over local and wide area networks.

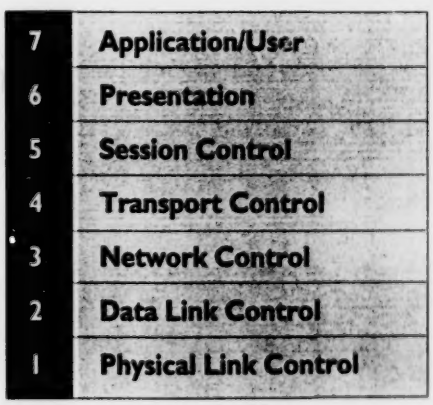

Figure 1-2

The ISO model uses a layered approach, each layer representing a component of the total process of communicating.

Of course, a particular set of computers may understand more than one protocol for data transmission. Just as people have different languages, different protocols have been defined to support basic data transmission for particular applications and products. However, if we want to send a letter to a person in another country, the post office will use a common convention for transporting that parcel internationally. Whereas on the local level we may use many different "protocols" for communicating, when we want to communicate broadly we must rely on a more limited but commonly understood set of protocols. This is the basis on which the world wide "network of networks" known as the Internet has been built.

What Is the Internet?

The Internet is a vast and rapidly growing collection of interconnected networks that all support a common set of data communication protocols. The most commonly known of these protocols are the Transmission Control Protocol (TCP) and the Internet Protocol (IP), which together are referred to as "TCP/IP." Thus the Internet is often referred to as a TCP/IP network.

The Internet began as a federally funded experiment through the Defense Advanced Research Projects Agency (DARPA). It quickly became known as the ARPANET. By the late 1970's many government research labs and universities across the nation had received DARPA grants to work on communications and/or computing problems. These institutions began building local area networks on their campuses and connecting them into the ARPANET so that they could share information and resources with one another. The impact of this widespread development of networking was the refinement of new protocols and network applications.

By the mid 1980's, the success of the ARPANET overwhelmed its limited capacity. Recognizing the potential of networks to enhance the value of many of its grant programs, in particular the supercomputer center initiatives, the National Science Foundation (NSF) funded a new "national network infrastructure" in support of all national education and research goals. The backbone of this infrastructure, known as the NSFNET, replaced the ARPANET and greatly enhanced the capacity and scope of network connectivity.

The NSFNET architecture required the development of regional networks to serve as distribution systems within specific areas of the country. Initially NSF provided seed funding to start 13 regional networks, including 2 in California: the Bay Area Regional Research Network (BARRNet) in the north, and the California Education and Research Federation Network (CERFnet) in the south.

Today there are many regional and state networks as well as several commercial national network service providers. The non-government funded service providers support commercial use of their networks which has led to a large number of such networks joining the Internet infrastructure. Many international links exist as well, connecting networks in Europe, Asia, South and Central America, and Africa.

How Do We Create a Network for Our School System?

This is the question to which the rest of this document is devoted. This guide does not provide a blueprint for you, nor would that be practical since there are so many differences among your schools and districts. What this document does provide is a framework of essential information within which you will be able to build a plan that meets the unique needs of your site(s) while remaining compatible to those standards and protocols already established by the state and the nation.

Chapter 2

K–12 Networking: A National and Statewide Perspective

Introduction

During the past decade integrating new technologies into the learning environment has been gradually growing in importance as a goal for K–12 educators. In particular, networking has been highlighted as a cost-effective tool for improving learning opportunities for all students, supporting professional development, increasing the productivity of all members of the learning community, exponentially increasing the number of resources available to K–12 schools, and improving the efficiency of school, district, and state administration.

Today, schools across the country are working diligently to speed the introduction of networking into their learning communities so that they can capitalize on the vast benefits of this technology. However, although examples exist of productive uses of networking in schools, most schools are still resource-deprived and most students and teachers have little or no access to the networking tools of the information age.

In this section we address developments on the national level and then within California to provide some clarification and describe the correlation between the school networking plans described in this document, the state initiative called the Golden State Education Network, and the National Information Infrastructure (NII), commonly referred to as the Information Superhighway.

The National Information Infrastructure

The NII has the potential to improve equity of access to networked resources for K–12 schools nationwide. The NII is being designed to make possible electronic interconnection of the nation's industry, government, education, health, and research communities, including K–12 schools, thereby facilitating research and development collaborations and enhanced access to information resources and computational capabilities.

President Clinton's Administration announced the NII initiative in September 1993, spearheaded by Vice President Albert Gore. An excerpt from the document titled "The National Information Infrastructure: Agenda for Action" provides some insight into the meaning of the NII:

"All American have a stake in the construction of an advanced National Information Infrastructure (NII), a seamless web of communications networks, computers, databases, and consumer electronics that will put vast amounts of information at users' fingertips. Development of the NII can help unleash an information revolution that will change forever the way people live, work, and interact with each other:

- People could live almost anywhere they wanted, without forgoing opportunities for useful and fulfilling employment,

by 'telecommuting' to their offices through an electronic highway;
- The best schools, teachers, and courses would be available to all students, without regard to geography, distance, resources, or disability;
- Services that improve America's health care system and respond to other important social needs could be available on-line, without waiting in line, when and where you needed them.

The benefits of the NII for the nation are immense. An advanced information infrastructure will enable U.S. firms to compete and win in the global economy, generating good jobs for the American people and economic growth for the nation. As importantly, the NII can transform the lives of the American people—ameliorating the constraints of geography, disability, and economic status—giving all Americans a fair opportunity to go as far as their talents and ambitions will take them."

The Clinton Administration's position, as described briefly above, grew out of the following five principles:

- Encourage private investment
- Provide and protect competition
- Provide open access to the network
- Avoid creating information "haves and have nots"
- Encourage flexible and responsive government action

The Administration has called for public-private partnerships to construct the NII. Changes in legislation that affect the telecommunications industries are being addressed by Congress, and those industries that provide telephone, cable, wireless, satellite, etc., are beginning the development of a national communications infrastructure.

The Statewide Perspective

California, a state which has been a leader in restructuring and other important reform initiatives, is taking a leading role by working to prepare its schools to take advantage of networking, the NII, and other emerging technologies which have not yet even left the drawing boards.

The Strategic Plan for Information Technology

In order to address the compelling need to assist schools in taking advantage of information age resources, help ensure equity of access, and position California as a leader in taking advantage of emerging information technologies, former Superintendent of Schools Bill Honig established the Advisory Committee on Information Technology (ACIT) in July 1990. The charge of ACIT was to develop a strategic plan defining the best approach to building a statewide electronic communications highway that would extend to all schools, districts, and county offices of education throughout the state. In September 1991, ACIT presented a document entitled *Strategic Plan for Information Technology* which described the vision, mission, and recommendations of the group.

As a result of the *Strategic Plan for Information Technology*, the Department of Education established a Technical Planning Committee consisting of representatives from local school districts, county offices of education, and institutions of higher education to determine the most expeditious and cost effective way to implement the plan's recommendations.

After thorough research and consultation with numerous advisors, the Technical Planning Committee recommended that California design its networking standards and protocols so that California education networks would be compatible with the Internet—the most pervasive, functional, democratic, and well supported network infrastructure that exists today. An infrastructure designed with this compatibility, it was successfully argued, would provide California schools and districts efficient and low-cost local communications capabilities, extensive

cost-effective worldwide communications, and the ability to take advantage of new communications technologies as they emerged.

The Master Plan for Educational Technology

For reasons similar to those cited in the creation of ACIT, the Farr-Morgan-Quackenbush Technology Act (AB 1470) of 1989 established the California Planning Commission for Educational Technology (the Commission) to create a master plan for educational technology in California schools. In 1992, the Commission submitted *The California Master Plan for Educational Technology* identifying a number of objectives crucial to the future success of education in California. "Chief among these objectives are: 1) equity of access to technology resources; 2) equity of resources anywhere learning and teaching occur; 3) coordination of resources from public and private providers; 4) electronic linking of educational agencies; 5) and the coordination of educational technology among the four segments of California public education: K–12 education, California Community Colleges, the University of California, and the California State University."[1]

In addition, the Master Plan recommended the establishment of the Golden State Education Network (GSEN) coordinating an integrated voice, video, and data link of existing networks. GSEN will eventually become the schools connection to the NII.

The Educational Technology Act — Senate Bill 1510

In 1992, the Morgan-Farr-Quackenbush Educational Technology Act (Senate Bill 1510) authorized the establishment of the statewide education telecommunication network, GSEN, to deliver voice, video, and data to all learning locations in California, including public schools, college and university campuses, homes, libraries, museums, and community agencies. The statute references both the ACIT and the Commission reports and lends legislative support to the Technical Planning Committee's endeavors to define a standard network infrastructure and set of network protocols for California.

SB1510 also mandated the creation of the Education Council for Technology in Learning (ECTL) to support educational technology in California. The ECTL is charged with allocating educational technology funds and implementing the Master Plan for Educational Technology as well as collaborating with the Industry Council for Technology in Learning. Currently, both groups are working toward the implementation of the statewide network infrastructure, identifying funding resources to support the effort, and developing the implementation of technology programs in the schools. The ECTL has appointed a GSEN-Communications Task Force as required by SB 1510. The work of the Technical Planning Committee will be continued through this Task Force. This group is composed of K–12, higher education, industry, and CDE representatives who will design the statewide communications infrastructure which will provide connectivity for school networks to larger existing networks across the state.

The K–12 Network Technology Planning Guide

This document, the *K-12 Networking Technology Planning Guide*, incorporates the research and recommendations of each of the three previously described efforts to bring networking technology to K-12 schools. However, unlike the earlier reports, this document specifically outlines the technical specifications recommended for the school infrastructure, implementa-

[1] California Planning Commission for Educational Technology, "California Master Plan for Educational Technology," April 22, 1992, p.iii.

tion issues which must be addressed in order for the network to be successful, and the priority which must be given to each of the network's elements. Though not all of the technologies are readily available today to establish complete voice, video, and data networks for K–12 schools, the network design put forth in this document allows schools to move forward now, incorporating these technologies as they become available and affordable.

The Technical Planning Committee and the California Department of Education believe this document provides ample concrete information to make possible expeditious implementation of the networking infrastructure and, most importantly, will help speed the day when all members of California's learning community can enjoy the exciting benefits of networking on the statewide, national, and global levels.

PART

II

MAKING THE CASE

Chapter 3

Benefits of Networking

Chapter 4

Focus on the School

Creating and maintaining a technology infrastructure requires significant funding and an ongoing commitment of resources. For many schools, the first step on the road to technological development is making a case that demonstrates that the benefits of this investment are worthwhile educationally and administratively. This section of the *Guide* outlines many of the immediate benefits of networking and provides examples of ways in which your school or district might go about realizing maximum return on these investments.

3

Benefits of Networking

In the 1950s Americans began to realize the benefits that would result from a national investment in a network of multi-lane, limited access highways that would enable people and goods to move efficiently and cost effectively across the country. In the 1990s the benefits of the much talked about information superhighway (as well as the physical nature of its structure) are being explored by an increasing number of Americans. As they are enlightened to the overwhelming economic and social benefits of such a superhighway, these individuals are demanding that the designers of this infrastructure map its course directly to their homes, offices, and schools.

For educators who have already discovered electronic communications, its use has been the catalyst for a paradigm shift. A true paradigm shift causes a revolution in thinking or perception which makes thinking in old paradigms virtually impossible. Educators using the Internet have found that instantaneous global interaction and access to vast, up-to-date resources are more readily available then ever before. It is no wonder they are forever rejecting the isolation and resource deprivation which have been the norm for so many years in our schools. In his description of the "school in the global village," Al Rogers (CUE Newsletter 1993) concludes:

"When teachers and their students are 'connected' to the world, teaching and learning strategies change. The 'world' becomes an indispensable curriculum resource. When students communicate with people in distant and foreign places they begin to understand, appreciate, and respect cultural, political, environmental, geographic, and linguistic similarities and differences. Their view of the world and their place in the world changes."[1]

The networking benefits discussed in this chapter are by no means exhaustive. In fact, one of the most appealing features of the Internet is that its applications and benefits are direct reflections of the creativity and innovation of its users. With each new user of the Internet arrives a unique viewpoint, a new body of information and life experiences, and therefore, new potential benefits to other users.

Impact on Communications

Very rarely in the history of humankind has a technology been invented which has the potential to revolutionize communication. The introduction of the Gutenberg Press in the 1450s precipitated a revolution in the communication of that era by providing a technology which dramatically increased the production and distribution of printed information. Prior to this technology, written documents were limited to a few powerful custodians of information. Following the introduction of the press and the mass distribution of information (primarily copies of the Bible), social upheaval occurred. As the Protestant Reformation demonstrated, citizens make informed and stunning decisions given the opportunity to educate themselves with unedited information. Similarly, electronic networks are revolutionizing our era with

[1] Al Rogers, "Global Literacy in a Gutenberg Culture," CUE Newsletter, Nov/Dec 1993, Vol. 15, No. 6.

their ability to facilitate instantaneous transfer of visual, audio, and printed information worldwide. Whereas distribution of Gutenberg printed materials provided the first opportunity for citizens to examine the most influential resources of their day, today's networks are providing the first opportunity for millions of individuals to gain access to primary source information from around the globe which in prior years was essentially unavailable to all but a privileged few.

The impact that this powerful, interactive medium for communication is having on education is profound. As professionals, teachers want and deserve to communicate with their peers, yet few schools can provide teachers opportunities for such interaction. Teachers and other educators linked to the Internet are conversing with colleagues across their districts and around the world in ways they never before imagined possible using news groups, mail lists, and electronic mail (email) to maintain these dialogues throughout the year (for detailed definitions of these services see Part III, Chapter 7, Network Services). Networking is also reducing the intellectual isolation of classroom teachers by facilitating global collaboration among teachers and scientists, business people, university faculty, and specialists in hundreds of fields. These collaborations, often referred to as electronically linked communities or virtual communities, promise to transform the way many educators and students work. In addition to creating dialogue they encourage exploration, teamwork, experimentation, open communication, and, perhaps most importantly, support the sharing of good practices.

Communication via the Internet is also having a significant impact on the resources available within classrooms. The Internet is connecting students and teachers to: other students and working professionals worldwide, literary and scientific archives, book and movie reviews, full texts of the plays and poems of hundreds of authors, electronic newsletters and journals, US Supreme Court opinions, the CIA's vast collection of data on every geographical region of the world, collections of humor and folklore, bibliographies, up-to-date weather and earthquake conditions and forecasts throughout the world, lists of Internet-accessible news groups, mail lists, services and help/reference documents, and many, many more sources of information which support students to become self-directed learners and teachers to become flexible and well informed.

Students with Special Needs

As networking technologies emerge, we have a responsibility to ensure that information tools are compatible with readily available adaptive computer technologies for individuals with disabilities. In recent years, adaptive computer technologies have empowered individuals who must learn and work differently. Talking computers, adaptive keyboards, scanning technologies, refreshable Braille output, and a host of other adaptive programs and devices are helping to eliminate barriers to communication in classrooms and workplaces nationwide. Individuals who are unable to speak are communicating more clearly using computers. Individuals who are unable to see or comprehend print materials listen to what is being spoken by the computer as it scans text. Those who are unable to freely move from one location to another are able to gather information, unhampered by distance and physical barriers. For many of these individuals, they are able to communicate, work and learn in an accessible environment for the first time in their lives. The future of today's students with disabilities is brighter because of the potential for technology to accommodate their special needs. These students must have the opportunity to transition into the workplace or higher education, carrying with them the skills

necessary to use information technologies competitively. Critical issues of persons with disabilities are presented in a report titled *Telecommunications and Persons with Disabilities: Building the Framework* (1994). This document was prepared by the Blue Ribbon Panel on National Telecommunications Policy and the World Institute on Disability.

Impact on Participation and Understanding

As the social and economic issues of the information age have increased in complexity, our society has found itself lacking in tools for engaging and educating its citizenry. Declining voter registration and even greater declining voter turnouts attest to the toll the alienation of our citizenry is taking on our democracy. Though mass media is pervasive, it presents information as though there were ready answers to complex issues. Because it is very difficult for mass media to convey significant detail about a topic in a manner that is interesting to its broad audience, it is relegated to finding the acceptable level of detail, or lack thereof, and an engaging way to present it. By virtue of the medium's technological constraints, viewer participation is extremely limited. The Internet, with its endless resources, voices, points of view, and images provides educators a serious but engaging tool for fostering student curiosity and literally demands an interactive relationship between the individual and the information he/she is receiving.

Through thousands of news groups, mail lists, and email dialogues, users are encouraged to participate, ask questions, dig deeper, and study more extensively. Curious lifelong learners are respected and supported, regardless of their level of expertise. The impact this social design has for education is revolutionary in scope.

For example, during the Gulf War in 1991, CNN stunned the world by airing unedited, real-time coverage of events occurring in Iran and Iraq. Millions of viewers around the world were astonished by the immediacy of the information they were receiving; but after just a few short hours that information became repetitive and, at times, conflicting. As viewers, students had no way to explore further the issues which most concerned or confused them. Educators wishing to integrate the broadcast events into the curriculum were hard-pressed to do so.

Compare this example to a situation which occurred in 1993. Parts of Los Angeles erupted in rioting; television crews once again rushed to provide us pictures of what was taking place. But for students linked to the Internet in the Bay Area and in Los Angeles a personal dialogue was initiated almost immediately. "What was it like to be a kid in a riot? Was the whole city really on fire? Was it scary?" These were just a few of the questions that elementary school students were able to pose to their peers in Los Angeles, allowing them the opportunity to find and respond to the news they cared about, not just what the networks had determined was appropriate to cover. Teachers in these classrooms took this opportunity to lead students into ongoing dialogues about social history, racism, criminal justice, and even regional economic development.

Through this kind of interaction, learners in networked classrooms quickly discover the energy and joy of learning collaboratively with others worldwide. Student curiosity and motivation increase when learning is linked to real-world problem-solving. Teachers find themselves coaching students through complex analysis and synthesis of information, often stunned by the concentration and commitment students demonstrate towards their learning. The teaching of skills such as critical thinking and teamwork, as advocated in California's curriculum frameworks and education reform documents, is greatly supported by

the participatory nature of the Internet. Many teachers find that their students develop a much greater interest in diverse perspectives as a result of their Internet interactions.

Reconstruct and Improve Teaching

> "In the last decade of the twentieth century, teacher-centered, textbook-oriented education is largely obsolete. Internetworked communications offer students access to more information than teachers can possibly master, as well as an immediacy and currency of information that textbooks—periodically adopted and distributed—can never maintain.
>
> Effective use of this technology, however requires that teachers shift from whole-group, frontal instruction to coaching individuals and small groups of students, and move from 'telling' information to 'facilitating' information-gathering and the integration of knowledge."[2]

Impact on Creative Expression and Critical Thinking

The ability to share ideas via the Internet is providing users an unrivaled vehicle for creative expression. No longer dependent upon publishers, mass media, and other traditional distribution channels, thousands of writers, poets, scientists, musicians, students, and others are making their work available to others around the globe. The existing latent creative talent surfacing in the exchanges of the Internet confirms that as individuals we have not yet become nearly as passive or simple-minded as critics of our society, and our education system, would lead us to believe. On the contrary, given this vehicle for being heard, individuals of all ages are engaging in complex, educational, and highly creative interchanges.

In order to prepare themselves for these interchanges, students at all skill levels are demonstrating an increased interest in reading and writing. Students who believe their work will be read by a truly interested audience excel in writing above their individual past performance levels; they learn quickly that in order to be understood, they must express themselves clearly and rise to the challenge. Similarly, students receiving information they have requested or specifically searched for often read above their past skill level with great determination; these students care about the information before them and find purpose and reward in working hard to comprehend even difficult materials.

Teachers and students exploring the Internet together are developing skills for questioning, researching, analyzing, discussing, hypothesizing, and proposing. These capabilities are gradually replacing the traditionally valued skills of objectification and memorization. As students and teachers together learn to become more creative, the Internet provides them a mechanism through which they can share their enthusiasm and discoveries with others. In this scenario, the networked classroom becomes a place where information is viewed as a starting point, critical thinking is essential, and creative application of information is the key to learning.

[2] Report to the National Education Goals Panel, "Achieving Educational Excellence by Increasing Access to Knowledge," July 27, 1993.

Chapter 4

Focus on the School

Throughout this document we have alluded to the many ways in which networking can support teachers, students, and administrators. In this chapter we briefly illustrate some of the ways networks, and the Internet in particular, can contribute to the development of new curriculum and collaborative learning, the design and implementation of restructuring efforts, and the administration and organization of schools and districts.

Introduction

Imagine you are suddenly given a low-cost tool which enables you to rethink the way learning takes place in your classrooms by taking advantage of a vast array of new information resources and thought-provoking creative challenges. How would you begin to take advantage of this powerful tool?

Rather than being a far-fetched scenario, this is the exciting opportunity and the accompanying dilemma facing the thousands of educators who have recently been introduced to networking. After years and years of isolation, educators find themselves with instant access not just to a few pre-selected resources, but to an infinite number of individuals, organizations, conferences, and research institutions posting primary source information every minute of every day worldwide. Envisioning the possibilities such connectivity will provide administration, staff, and students is the vital first step in designing relationships with the network.

In this *Guide* it is recommended that a school or district create a network infrastructure that provides access to local resources and to the Internet, the most comprehensive "network of networks" in existence today. The Internet's primary purpose has been to facilitate and foster communication among researchers and higher education, to make possible long-distance collaboration, and to provide a vehicle through which images, text, and computer applications can be exchanged. Only recently has this network been recognized by the K–12 education community as a valuable tool and have local and state resources been allocated to support access to it.

As described throughout this document, the Internet provides a wide variety of capabilities beyond those available through local networks. As illustrated below these capabilities translate into an even greater number of educational opportunities when they are meaningfully woven throughout a well-designed networking strategy.

Focus on the Classroom

In general, local area networks provide classroom teachers several important services (e.g., the opportunity to exchange mail with local colleagues, to share printers, to use local file servers, etc.). Access to

the Internet greatly expands the number of networking opportunities available to teachers and students. These opportunities fall into three basic categories: one-to-one communications (email), one-to-many/many-to-many communications (e.g., bulletin boards, listservs), and data exchange. The various tools and resources on the network facilitate use of the network in these various forms.

The first and most pervasive form of one-to-one communications on the Internet is electronic mail or email. Email provides users the opportunity to exchange personal communications, or "letters," with any of the five million Internet users, as well as with subscribers to commercial online services. In the classroom, email enables students and teachers to share information and ideas with other students and teachers worldwide, exchange information with working professionals, and receive individualized instruction from distant mentors.

"As students or educators engage in dialogue with other participants in an email network, they might work on joint projects, gathering data, exchanging ideas, and perhaps getting tips from online experts. The significance of a topic comes to life as real people respond with new views, questions, and comments. The seemingly abstract concept of communicating electronically likewise becomes concrete as students receive electronic feedback."[1]

The second mode, one-to-many/many-to-many communications, allows individuals or groups to place messages on an online bulletin board, where they can be read and commented on by a host of other users in the network. This kind of communications on the network is often accomplished through applications and services such as listservs and USENET News (see Part III, Chapter 7, Internet Services). Using listserv, for example, the users participate in worldwide discussions which are conducted using email. Once a user or group of users have subscribed to a listserv, he/they can read and respond to questions and issues generated by others who have also joined the group. Very similar in function is a service referred to as USENET News. Like listserv, USENET allows users to participate in online discussions with other users located anywhere on the network. Unlike listserv, however, the messages generated by the groups are not delivered via email but rather are accessed using a separate application.

An important distinguishing feature of Internet discussion groups is that participants are free to send and receive as many messages as they wish, and are not limited in their participation by incremental costs and/or the constraints of their subscription. For example, a user accessing a commercial on-line service will usually pay ordinary phone charges, a subscription fee, hourly use charges, and in some cases, per message charges for individual emails. By contrast, once access to the Internet is established for a user, incremental usage costs are not a concern.

The third mode of classroom use, data exchange, includes information retrieval and publication. Information retrieval can be achieved using a number of applications and services, such as Fetch, Telnet, Wide Area Information Services (WAIS), and Gopher (see Part III, Chapter 7, Internet Services). The value of each of these applications is that the user can retrieve information from computers and databases worldwide, often in a mater of seconds. Similarly, the Internet provides an extremely cost-effective vehicle for information dissemination. Individuals, classrooms, schools, county offices of education, state departments, and even national agencies use the Internet to send announcements, articles, inquiries, requests for proposals, research, and other

[1] Peter Grunwald, "Telecommunications in the Classroom," *The Electronic School*, October 1991, A4-6.

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information to targeted, or sometimes very large, audiences.

The Internet, Curriculum, and Project-based Learning

With these basic, and by no means exhaustive, modes of Internet use in mind, consider the following current examples of Internet usage by K–12 students and teachers in California:

- Students participating in Global Lab, an NSF-funded project, study local and global ecological change, using new instruments and sensors such as ozonometers, ion-selective probes, and field data loggers. When students in Boston and Moscow establish uniform guidelines to compare the environmental quality of their study sites, they learn both the rigors and excitement of research science.
- A 7th grade language arts teacher plans to use Kidsnet to find teachers and students in other parts of the world willing to exchange writing with her class. Together they will write iterative stories and edit each other's works;
- A 6th grade teacher is using NASA Spacelink and other telnet sites for cross-curricular projects integrating science, history, and social science;
- A special education teacher in a remote rural district sees the Internet as her best means for accessing information and, more importantly, communicating with others who are interested and involved in new movements and are trying new teaching methods.
- A 6th grade teacher plans to link her students to scientists worldwide in order to study topics such as: changes in forest composition over time, effects of oil spills, changes in kelp distribution over time, comparisons of urban/suburban/rural landscapes, and remote image processing and sensing.
- A high school physics teacher plans to enhance his physics curriculum by having his students compile an Internet portfolio containing text, computations, and graphics that together give a complete description of the forces acting on a flying boomerang and the effects of those forces. His research indicates that a large number of articles are already available through WAIS and by using the FETCH and VERONICA tools. His students will also receive information from NASA Ames that can be used to create images on the Silicon Graphics workstation at the school.
- A middle school visual arts teacher is subscribing to three conferences: ARTIST-L (a student art discussion), ASTUXCH-L (a student exchange in art, architecture and design), and GRAPHIX (a computer graphics referral). Using the Education Research Information Center (ERIC) she will have her students explore art archives, and in the future, she hopes to link her students by email with working artists.
- A high school teacher will teach literacy, using the Internet to facilitate online data searches.
- A teacher is attempting to create a Hypercard share Gopher service so that teachers and students can more easily locate Hypercard stacks created by others; he hopes to eventually convince the State Department of Education to act as home base for the stacks.
- A middle school teacher is working through CSIN (a network of over 1,400 science teachers in California) to use Landsat-type imaging to design open-ended environmental research units.
- 4th grade students in one school are acting as "experts," using their own research and encyclopedias to answer email questions sent by 1st graders at another school;
- A 1st grade teacher is having her students send email to other students about who they are and what their

families are like (communication of this sort is closely monitored by the teacher to ensure that no information is sent across the network which could compromise a family's safety or privacy);
- An elementary school Spanish teacher is having her students communicate with native Spanish-speaking children in other schools in order to improve their written communication and learn more about Spanish speaking nations.

In each of these examples, a teacher or group of teachers thought first of what they wanted to teach and then used the network as a tool for bringing a broader variety of information and human resources to their students. They correctly perceived that the network would enable them to overcome barriers of distance and time to connect their students with thousands of others worldwide.

Maximizing the Network's Potential

The Internet is the most powerful tool the information age has created for enhancing curriculum for students of all ages, but its use promises a certain amount of unpredictability. The vast number of possible contacts for students and teachers requires that educators using the Internet be prepared to learn along with their students, adapting their curricula in order to use each unexpected response as an educational opportunity. As pointed out by Eugene Nuccio, "the integration of computer hardware and software into classroom instruction is more dependent upon modification of instructional behavior than their level of sophistication with computer technology."[2] For example, imagine the following scenario:

Joseph, a fifth-grader is instructed by his teacher to log onto the network once a week and send email to a fellow student. Joseph does as he's told, enjoying the opportunity to use the computer and talk to a stranger about movies. While playing on the network during his lunch, he discovers that he can print book reviews that students at another school have written. When he tries incorporating one of these reviews into his own book report, his teacher tells him the reference is unacceptable because she did not list the source he used as one of the acceptable reference materials.

Imagine, in contrast, this example of Internet use in the classroom:

A group of students and teachers post the following message to FrEdMail (an educational network):

"We are planning a school-wide observance of the coming together of *Two Old Worlds* in a World's Faire-1492. We are interested in your children's response to the question, 'Was Columbus a Hero?' We look forward to hearing from students from around the globe."

The following two responses were among the many they received:

"Columbus was a hero because he was brave to sail uncharted sea and was courageous to face the unknown. He opened up the new world for others to explore and Magellan to circumnavigate the globe. Columbus went where no other man had gone before and discovered new places. He helped to prove that the earth is round."

Armaruth M. de la Cruz
Armstrong High School
Starkville, Mississippi

[2] Eugene Nuccio, PhD, "The Next Generation of Teachers: Past Skills, Future Models," *Journal of Educational Technology Systems*, Volume 18, Number 4 (1990), 279.

> "The first known European who 'discovered' America was Leiv Erikson from Iceland and Norway. If anyone should be called a hero it must be him!!! And to my knowledge he didn't kill any Indians. Columbus came there hundreds of years later and rediscovered the continent. And he thought that he came to India. He can perhaps be called a hero of second degree?"
>
> *Jan Wibe*
> Trondheim
> Norway

The receipt of the second response caused the teachers to rethink the curriculum, adding special emphasis to discussions on cultural perspectives and the biases in the teaching of history based upon national pride.

In the second example, the teachers leveraged the unpredictability of the Internet; in the first, the teacher tried to eliminate it. It is important to understand that the role of the teacher often becomes coach and facilitator, rather than "gatekeeper," when students embark upon their Internet navigation.

Educators are not alone in their quest to design exciting new opportunties for students which take advantage of the Internet's many capabilities. In fact, many universities and research organizations are looking for ways to connect their staff with students, particularly in the areas of math and science. For example, NASA is in the midst of a project to connect researchers in the Antarctic with K–12 classrooms nationwide. This project is called *Live from...Other Worlds* and features three live television broadcasts from Antarctica accompanied by on-line activities and teachers' guides (which are available via Gopher and File Transfer Protocol (FTP)). So that teachers can maximize the benefits their students receive from this series, the teachers' guides include topics such as:

- Mars Via Antarctica (Activities for grades 5 and up)
- Long-Distance Data Transmission (Activities for grades 5–10)
- Student Drivers...Robot Drivers (Activities for grades 5–10)
- Building a Robotic Arm (Activities for grades 5–10)
- Roving 'Round Mars:
- Creating/Exploring a Virtual Environment (Activities for grades 6 and up)
- Mapping
- Creating a Virtual Environment
- Searching for Life
- Suggested Further Reading and Audiovisual Resources
- Glossary and Key NASA Missions

The NASA series is one of many which are available at no charge to teachers; others, such as CNN News Guides, do have associated charges. If the current trend continues, the number of these resources will increase dramatically over the next five to ten years.

Collaboration: Overcoming Barriers of Time and Distance

Another primary benefit of connectivity to the Internet is that communication can occur at any hour of the day or night and, perhaps more importantly, can occur without individuals having to arrange to be absent from their workplaces and/or classrooms. This is of particular importance to rural school districts, which face substantial obstacles in overcoming their isolation. Without the traditional constraints of scheduling and the commute time required to visit the school, working professionals are able to contribute to classroom activity and curriculum development in a more iterative fashion.

Barry Kort, a visiting scientist at Bolt Beranek and Newman, Inc., writes of his enlightening experience exchanging email with a 7-year-old-student:

While one might expect electronic mail to be used primarily by academics and professionals, this author, for over a year, exchanged email with a 7-year old boy in Atlanta. With an average of 2 letters per week, the transcripts of my correspondence with Abram now fill a 1-inch binder. The format of the exchange is Socratic Dialogue, with the intent of engaging Abram in exploration of scientific material. Abram's literacy and communication skills have improved dramatically while his scholarship, attitude toward school, and self confidence have progressed from problematic to exemplary. That computer networks can enable a professional scientist to reach into the home and the life of an American child is a testament to the largely untapped potential of network technology.

Another wonderful example of scientist / student collaboration can be seen in this excerpt from a series of email exchanges between Paul Smith, a physics doctoral student from Melbourne working at Casey Research Base in Antarctica, and sixth grade students in Lincoln, Nebraska:

Q: *What is your job in Antarctica?*

A: I am helping set up an instrument called an ionosonde that can be used to study the lower ionosphere (region from around 90km to 500km high.)

Q: *What is your degree in?*

A: I did a bachelor of science degree 4 years majoring in physics and computer science. Now I'm doing a PhD in electronic engineering and physics. I've done a bit less than a year of that so there will be another three years to go I expect.

Q: *Do you have pets there?*

A: Nobody is allowed to introduce foreign animals into Antarctica now, because of the damage they will probably cause. The huskies or sled dogs are being taken back to Australia...This is not a popular decision at some of the stations because they're really treated as pets there and are also seen as a part of the history of exploring Antarctica. However there is a new set of guidelines being introduced called the Madrid Protocol that requires all non-native animals to be taken away. Probably the best thing to do in the long run.

Q: *Why did you want to work in Antarctica?*

A: Opportunity of a lifetime!!! After all this is one place that is not easy to get to, and I love traveling and seeing new places. It's not like anything else I've done in my life, that's for sure.

This kind of exchange excites students to careers in ways that classroom instruction alone cannot provide. As a by-product of their exchanges with working professionals, students are inspired to acquire and evaluate additional information, interpret and pose hypotheses, and test their ideas using computers as a tool to facilitate their research.

Beyond this, students benefit from the introduction of the Internet into their classrooms by having the opportunity to learn one of the most important skills required by employers in the information age, the ability to work with "colleagues" from diverse backgrounds to solve problems. Students graduating from today's schools not only need a sense of what knowledge is and what the pursuit of knowledge means but also need to know how to communicate to others what they have learned and how to get access to what others are learning. This need was recently articulated by the Committee on Physical, Mathematical, and Engineering Sciences and the Federal Coordinating Council for Science, Engineering, and Technology in a report on the High Performance Computing and Communications Initiative. The report concludes:

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> ...a growing number of science and technology fields, progress and productivity in modern research are increasingly dependent on the close interaction of people located in distant places, sharing and accessing computational resources across networks.

Reaching a similar conclusion, the United States Department of Labor June 1991 SCANS report: "What Work Requires of Schools - A SCANS Report for America 2000" states that among the skills and competencies necessary for students entering the workplace are the ability to:

- acquire and evaluate information;
- organize and maintain information;
- interpret and communicate information;
- use computers to process information;
- work well with men and women from diverse backgrounds; and
- work toward agreements involving exchange of resources, resolving divergent interests.

In a recent article, Beverly Hunter,[1] formerly a program director at the National Science Foundation, states:

> Increasing numbers of educational improvement projects are designed with the assumption that learners and teachers should interact with geographically and institutionally distributed human and information resources. A further characteristic in many of these projects is that learners become contributors to the collaborative knowledge base of the learning community in addition to being users of other's data and expertise. Students and teachers become connected to the global community and the gap between the world of school and the world of work is narrowed. For example, in the popular Shadows project, children from around the world measure noontime shadows of a meter stick on their schoolyards. They then share their data with the other participants, and use the collective data to compute the earth's circumference.

Another example of the Internet as a collaborative vehicle is the "Learning Through Collaborative Visualization" project in which students and teachers in Boulder, Colorado, study atmospheric science with scientists at the University of Michigan, San Francisco's Exploratorium, the National Center for Supercomputer Applications in Champaign-Urbana, and TERC. Students access multiple representations of the same weather phenomena using National Weather Service data and satellite images. In addition, they are experimenting with two-way audio-video technology being developed by Bellcore and Ameritech.

In addition to providing an excellent vehicle for student collaboration, the Internet opens many doors for teachers, reminding them of the excitement and "sense of opportunity" they first felt when embarking on their careers. This excitement is conveyed in the following testimonials from teachers who have just completed their first year of Internet use:

I have been given the opportunity to utilize a computer,...email and information services in my daily lesson planning. It has altered the way I go about my job, and the way I perceive myself as a teacher such as no other thing thus far in my career... I have been led down a tunnel. At first the tunnel was new and scary...I began to realize there were all sorts of branches which I could follow. It has not occurred to me to turn back for I have learned too much, and I am having too much fun.

-Liz Matchett,
Spanish teacher, grades 5-8

...The Internet is the catalyst for integrating technology within our curriculum, and injecting awareness into our lives and into the lives of our students.

-Theresa Baker
Teacher, Technology Coordinator

[1] Beverly Hunter, "Coordinating Technology for Systemic Reform," *Communications of the ACM*, May 1993, Vol. 36, No.5.

The Internet and Restructuring

In addition to enhancing curriculum, use of the Internet provides many opportunities which support the restructuring efforts upon which many schools have already embarked. For example, in Table 4-1, Beverly Hunter in her paper "Linking for Learning: Computer-and-Communications Network Support for Nationwide Innovation in Education" provides examples of ways in which the Internet could support aspects of school restructuring (some examples have been adapted slightly):

Of primary importance to teachers engaged in restructuring efforts is the need to communicate with others regarding curriculum, assessment, governance, scheduling, and other school and classroom issues. The Internet is effectively facilitating a number of small and large forums to support these dialogues.

For example, the Geometry Forum, organized by Eugene Klotz at Swarthmore College, "is attempting to build a virtual community of research geometers, high school and college students and teachers, developers of instructional materials and researchers in geometry education. They are developing software for accessing the Forum that will support symbols, diagrams, and some hypertext features with a simple and convenient user interface. The conjecture being tested is that closer working relationships among researchers, teachers, and instructional developers will enable more rapid transformations of school mathematics curriculum content and teaching methods along the lines called for by the National Council of Teachers of Mathematics."[1]

Jim Levin and his colleagues at the University of Illinois have developed a model called "Teaching Teleapprenticeships," in which teacher-education students and practicing teachers participate in network-based activities with K–12

[1] Ibid.

Table 4-1

Educational Challenge/Trend	*Implications for Internet Use*
Reform instructional methods and curriculum in order to better meet the needs of diverse students and information age society.	Internet provides access to: research on teaching and learning; alternative instructional materials; access to individuals worldwide.
Forge closer linkage among school, community, industry, and home; essential to restructuring contextualized learning.	Build local network connections and organization to facilitate parent, business partnerships and linkages with organizations outside the school.
Collaborative learning is an increasingly desired goal and classroom method. Shift from competitive or individual to collaborative modes of learning presents major challenges.	The Internet supports collaborative investigation and research among individuals of all ages and nationalities modeling for students the new mode of work and study in the information age.
Curricula and teacher knowledge and continual updating. Action research by teachers is becoming more valued as teachers take innovator roles.	The Internet provides up-to-the-minute information in all areas of study and forums for teachers to share latest findings, curriculum, and assessment tools.

students and teacher educators. They are testing the notion that undergraduates learn more productively if they work directly with professional teachers and children throughout their undergraduate years.

In Mendocino, California, Cory Wisna, a middle school science teacher, is spearheading a grass-roots effort to create a conference specifically for math and science teachers in California. Using existing networks such as the California Science Implementation Network (CSIN) and the Math Renaissance Project, and with assistance from NASA, the Autodesk Foundation and the Telemation Project, Cory is designing his project to provide a curriculum sharing project for math and science mentors and staff developers. In addition to establishing the conference, Cory is also advocating for a training component to the conference so that eager participants without prior Internet experience can be brought into the dialogue.

School Administration and Governance

Networks and the Internet in particular support school administration and governance in many ways, including, but not limited to, those listed below:

Schools currently must wait an average of 24 days (and up to two months) for receipt of student information from centralized information centers. More than one million student records are shared each year between K–12 schools and institutions of higher education with the cost of sending and receiving these records exceeding $21 million. The cost to schools of reporting student information to the State of California exceeds $35 million. Local and state cost savings as a result of transmitting appropriate school records via the network are expected to exceed $15 million per year.

Specifically, the California Department of Education is developing a statewide electronic California Student Information System (CSIS) which will transfer student and school data quickly and reliably between schools, districts, county offices, the California Department of Education, postsecondary institutions, and other appropriate state and social service agencies in California. Transmitted information will include demographics, academic histories, special programs, standardized test scores, and other information as deemed appropriate.

Directives from state, county and district offices can be transmitted electronically at less expense and with greater speed using electronic bulletin boards, conferences, and other email groups. Similarly, central ordering (with timely updating) of cafeteria, janitorial, and other supplies as well as local ordering of supplies stored in central warehouses can be done by email, reducing time-consuming requisition processes and streamlining inventory databases.

Internetworking can bring back to life outdated and even obsolete equipment. Almost all computers currently found in K–12 schools can be networked as described in the *Guide*. This means that even older machines can be brought into effective service using inexpensive software which enables them to emulate terminals. These computers, many of which are now sitting idle, can be employed to transfer binary files, send and receive email, login to remote machines, and transfer files across the nets.

Grant announcements and guidelines can be rapidly disseminated throughout the system; applications can be prepared and reviewed using both conferencing and email. A central archive of successful grant applications, district/county grant-related regulations, and other grant-related data can be maintained for instant access by school personnel.

Many face-to-face administrative meetings can be eliminated by use of online conferencing. Local news groups and mail lists allow people at remote sites to contribute to planning, conflict resolu-

and other forms of decision making without the time and expense of arranging after-school and evening meetings.

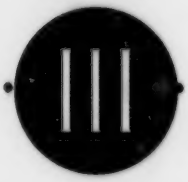
Networking is a first small step toward the paperless office. Initially schools with few computers may see an increase in paper use as the flood of new information must be printed to distribute to those who have limited network access. As computers increase in number the school may expect to reduce, though not eliminate, its consumption of paper.

School Site Councils and other school reform and governance bodies have free access to the vast Educational Resources Information Center (ERIC) database, which catalogues education-related books, periodicals, organizations, and other resources. One service, ASK-ERIC, does all the research on an emailed query and returns an annotated bibliography of sources and full text of appropriate studies completed by ERIC staff. Archives of school and district planning documents are being developed, and news-groups and conferences are continually being created to facilitate communication between and among educators with similar interests and needs.

Conclusions

Just as the largest economic and social challenges of our nation require new collaboration among geographically distant individuals, organizations, and governments, so the greatest challenges in school and curriculum reform require communication that has heretofore been minimal or nonexistent. Although there is no formula for how to integrate the Internet into all school activities, hundreds of examples of creative use exist. The quickest and most effective way to learn more about this is to join a conference, news group, bulletin board, or forum. Through these vehicles, people pose their own ideas for others to respond to, read about where others' work has led them, and work collaboratively with their students and peers to explore new possibilities one small step at a time.

PART



THE TECHNICAL PLAN

Chapter 5

A Technical Model for School Networks

Chapter 6

Network Servers

Chapter 7

Internet Services

Chapter 8

Network Support

Chapter 9

Security and Authentication

Modern communications systems are composed of many complex components and therefore must be carefully designed before implementation is begun. Because each site's network will be unique and site specific details and logistics are beyond the scope of this planning guide, it is critical that you work with experienced technical experts to design and implement your site's actual network. The chapters in this section of the *Guide* present sufficiently detailed design parameters and planning guidelines to enable you to work with these experts to implement a cost-effective, high-quality network which will be compatible with statewide information network services.

A Technical Model for School Networks

Introduction

The vision of a network serving all of California's primary and secondary schools has been articulated and discussed in many forums. Many schools and a few school districts have implemented *ad hoc* network systems in response to their own perception of the importance of this resource. This section of the *Guide* presents a standard network implementation model to assist county offices of education and school districts in their planning so that all such implementations will be compatible with each other and with the California Department of Education (CDE) network plans.

The future goal of "an integrated voice, data, and video network extending to every classroom" is exciting but so far from what exists today that the investment in time and dollars required to realize such a goal will be greater than most districts can muster in the near term. Yet a great deal can be done immediately, with relatively few dollars, to provide modern communications systems in and between schools throughout the state.

Our present goal is to define a highly functional, homogeneous, and well-supported network system that could interconnect California's K–12 schools and district, county, and statewide offices and that will enable teachers and administrators to begin to use new communications tools and network-based information resources. It takes considerable time to adapt curricula and other programs to take full advantage of new technology. Through the use of standard models for implementation of current network technologies, California's schools can begin this important process now.

Many states have already developed communications services for their schools. A notable example is Texas, which provides terminal access to central information resources from every classroom over a statewide network. The functionality that we propose for California will be much greater: direct access to the Internet and the emerging information superhighway from computers in every classroom.

The Internet communication protocols, commonly known as "TCP/IP," are the "glue" that will allow all computers to communicate.[1] Software that implements Internet protocols is available for all modern computers. These protocols support a very wide variety of applications, from electronic messaging to client/server data access. The use of Internet protocols will ensure that all networked computers will have direct access to the vast range of existing information and education resources on the Internet as well as to the emerging National Information Infrastructure.

Approach

The implementation we suggest would use current proven and cost-effective technology and would be expandable and upgradable to newer technology with minimum additional investment. This

[1] See RFC1432 for a bibliography of books on Internet technology.

approach requires careful, modular design to meet the following criteria:

1. Any physical infrastructure development should be general and flexible enough to be reused as technology improves. For example, a school office might have a simple terminal today which could be wired to a network adapter serving the school building. Later a Macintosh, DOS, or Windows-based PC might replace the terminal, and the type of connection to the network would change accordingly. However, the wiring between the office and the network "hub" site could remain the same if it is designed properly to begin with. This is an important consideration since wiring typically represents 20 to 40% of the cost of individual network hookups;

2. Existing computers and terminals in schools and district offices should be integrated as much as possible into the communication system. This installed base represents a large investment, albeit in many cases a somewhat dated set of equipment. Wholesale replacement of that base would be a large additional burden on funding resources.

   A consequence of the above is that the user interface and the services available will vary depending on the type of equipment used to access the network. For example, DOS PC's, Macintosh computers, or Unix workstations would be connected directly to Local Area Networks (LANs) and would be provided with communications software to support a broad set of functions, many of which will have graphical user interfaces and will make use of client/server technology. Apple-II computers, "dumb" terminals, or other such devices could be connected to intelligent network hubs that would allow access to network server computers or information resources but almost certainly will not support the full range of functionality provided by a direct network connection. In the short term, this is a limitation that we must accept;

3. Network servers will be located where they can be managed and supported and also provide access paths with adequate bandwidth. A system of hierarchical servers should be created in larger school districts, with automatic transfer of common information from a central system to the secondary systems each night, or at appropriate intervals. Local servers will allow each school to provide online information particular to its programs and community. This model optimizes use of network bandwidth as well;

4. School interconnect topologies (links) must be both cost effective and manageable. Communication between schools, district offices, county offices of education, and the State Department of Education must be reliable and of sufficient capacity to support the primary applications as well as allow development of new applications.

   Capacity is measured both by total data traffic volume and by response time when information is requested over the network. Reliability is measured by the percentage of time that the network is able to transport data. Reliability should be well over 99.7%. Capacity should be such that no more than 10% of the communications bandwidth is used during a typical work day. This is intended to leave adequate capacity for good response time to short term communication demands.

Many schools already have some form of communications infrastructure in place. In some cases this infrastructure can be adapted to newer technologies; in other cases it may have to be replaced over time. These issues are explored further following presentation of the basic

model that serves as a guideline for future communications system development.

Implementation Model

There is no one "blueprint" for a network that will drop into every school. Each school will have particular physical constraints, functional needs, an existing technology base, funding constraints, and opportunities for collaboration with vendors and support groups in its area. What is presented here is a set of general guidelines that can be followed in the planning of a school network implementation.

At present there is no statewide network "backbone" for K–12 schools. Interconnection of schools, districts, county offices of education and the California Department of Education can be accomplished by acquiring Internet connection service from any of the existing Internet service providers in California (see Appendix B). It is critical that Internet connection service meet the criteria for reliability and capacity. Connection to any Internet service provider will provide communication capability to all other Internet subscribers within California, the nation, and the world.

Internet technology is designed to allow very flexible intersite topologies, but a hierarchical topology is the simplest to engineer. Generally this will mean hierarchical connection of school facilities to district offices, in many cases further aggregated at county offices, and finally a link to an Internet service provider such as CSUNet, BARRNet, or CERFnet. Coordination of circuit services (through telephone companies) and a single point of connection to an Internet service provider serves both to minimize overall costs and increase opportunities to make use of newer technologies.

The basic school network implementation model is quite simple: create a local area network (LAN) within each school building or cluster of buildings, provide at least one network server for that LAN, interconnect that LAN with the local school district offices where a similar LAN should be installed and where centrally managed information resources should exist, and connect the district offices to the nearest Internet service provider, possibly through the county office of education.

Primary technical support for network monitoring and problem resolution and for managing network resource servers should come from the district or county offices initially to avoid unnecessary duplication at the local level. As expertise is developed at the local level, more of the responsibility for daily operation and problem resolution can be assumed by individual schools.

It is impossible to cover all conceivable scenarios for implementation of this model in specific schools. However, it is possible to state general principles that should be followed in designing school network implementations. The discussion below is organized into sections corresponding to the basic model summarized in the previous paragraph. It includes a description of the general principles that are important to each level of the implementation.

School Local Area Network Implementation

A "school" is used here to mean a building or cluster of buildings that are managed as a unit and typically are on contiguous, district-owned property. Implementation of a LAN in this setting will involve installation of a cabling system to distribute the network throughout the structure(s), installation of premise wiring to support connections of computers and terminals to the network distribution system, installation of one or more network server machines in a central location[2] and provision of a network router and telecom-

[2] Other protocols, such as AppleTalk or Novell's IPX, may be supported on a school's local area network (LAN) as needed for local functions, such as printer sharing or local resource servers.

munications circuit or radio link to connect that school to the district offices.

The most common LAN technologies in use today are ethernet and LocalTalk.[3] Both are inexpensive and easy to install and maintain. Ethernet is adaptable to most modern computers and is built into high performance workstations, such as Sun, Hewlett-Packard, SGI, or Digital Equipment Corporation computers. LocalTalk is built into all Macintosh computers and is adaptable to DOS PC computers as well. Ethernet is roughly 20 to 40 times faster than LocalTalk. **Therefore ethernet is recommended for all computer connections, when possible, and for the school LAN "backbone" or network distribution system.**

[3] IEEE 802.5 Token Ring is not recommended for new installations. It is more expensive, and it is not available for as wide a range of computers.

Network Adapters and Software

Individual computers will require network or communications adapters and appropriate software. Table 5-1 gives basic recommendations for the computers most commonly found in schools. Basic communications software is available in the public domain for many personal computers at no cost. More sophisticated software is being developed by a number of vendors for applications such as electronic mail, dis-

Table 5-1: Network adapters and software for typical computers

Equipment Type	Network Adapter	Communication Software
Simple terminal	"Network Access Server" located centrally.	Built into the network access server.
Apple II, Amiga, Tandy, Commodore, older IBM PC's, etc.	Serial asynchronous port that will allow connection to the above.	Serial communications software that emulates a simple terminal.
Newer IBM, PC's	Ethernet adapter card with "10-base-T" port. "Thin-net" port may be used in lab clusters.	TCP/IP "TSR" software, for example, "FTP Software" package. Additional software for special applications.
Older Apple Macintosh computers	PhoneNet adapter (external) and shared LocalTalk to ethernet router, for example the Shiva FastPath.	MacTCP or equivalent plus "telnet" and "ftp". For example, NCSA Telnet. Additional software for special applications, eg. "electronic mail client".
Newer Apple Macintosh computers	May use same as the above. For higher performance, use an ethernet adapter card with "10-base-T" port. "Thin-net" port may be used in lab clusters.	Same as the above.
Unix workstations	Ethernet adapter card, if not already built in.	Typically comes with the basic system. Additional software may be needed for special applications.

tance learning, and multimedia database access. For example, the California Technology Project is developing very easily to use software for Macintosh and DOS or Windows PC computers that will enable access to a wide variety of information resources and services (see GINA, Appendix B). Schools should look at all the available software and base choices on required functionality and support costs as well as acquisition costs.

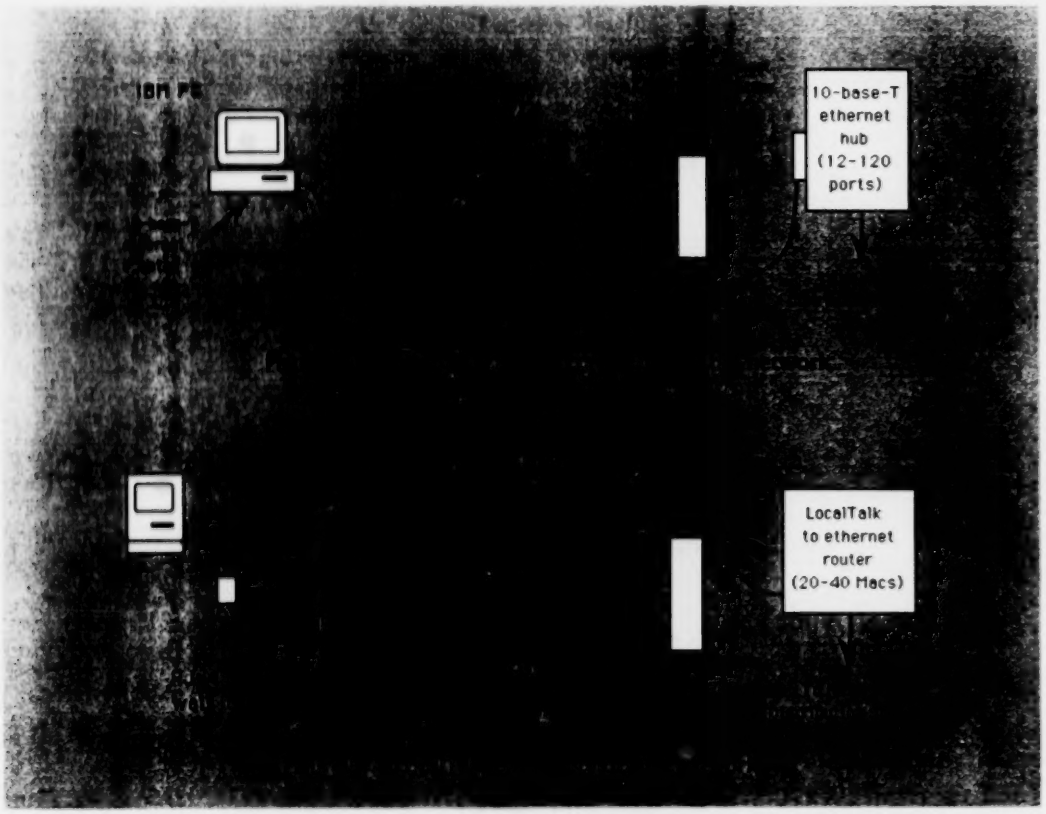
In locations where computers will be purchased, the choice of computer type should be driven by the availability of software for the particular application(s) to be supported. Almost all modern computers can be attached to the type of network described in this document.

Premise Wiring

A major component of the implementation will be installation of cabling to connect individual computers or clusters of computers to the LAN. **The recommended topology is a "star" where each computer is wired directly to a "hub site" within the building as shown in Figures 5-1 and 5-2.** A cluster of computers, typically found in a teaching lab or library, may be interconnected within the room where they are installed, and the cluster connected to the hub site with a single cable as shown in Figures 5-3 and 5-4.

The recommended premise wiring is "unshielded twisted pair" (UTP) wire that meets the Electronic Industries Association (EIA) category 5 standards for high speed data communication service.[4] While 2-pair cable may be adequate for most purposes, industry standards recommend installation of 4-pair cable. The difference in cost is minimal, so we recom-

[4]See EIA/TIA-568 "Commercial Building Telecommunications Wiring Standard."



mend installation of the latter. One end of each cable terminates in a category 5 RJ-45 jack[5] located near the computer. The other end terminates on a standard "110 distribution block"[6] at the hub site utility closet. A labeling scheme must be chosen and strictly adhered to so that cables can be identified at both ends later, as needed.

In most cases, the hub site utility closet will be shared with telephone services. It is essential that a separate wall area be set aside within the closet for data service interconnections. Typically there will be a "field" of interconnect blocks for termination of all premise wires, another field for termination of trunk cables (used for low speed data terminals), and a third field for hub equipment ports. Interconnections between premise wiring blocks and hub or trunk blocks are installed as needed in order to provide the appropriate service to each location where communication service is required.

Installation of wiring in a building typically is performed by a qualified data wiring contractor. This is a critical aspect of the program and must be planned and installed professionally with both current and future requirements in mind.[7] To be prepared for future distribution of video signals, school network planners should consider installation of RG-59 coaxial

[5] A standard RJ45 jack can be used for ethernet or lower speeds if initial cost is a major factor. Such jacks can be replaced with category 5 versions later as needed.

[6] In older sites, M66 distribution blocks may already be installed. These can be used for the time being but will not support newer higher speed technologies.

[7] See "Virtual Schoolhouse–A Report to the Legislature on Distribution Infrastructures for Advanced Technologies in the Construction of New Schools, K through 12" (Department of General Services, State of California, Feb 1993) for example conduit and utility closet plans.

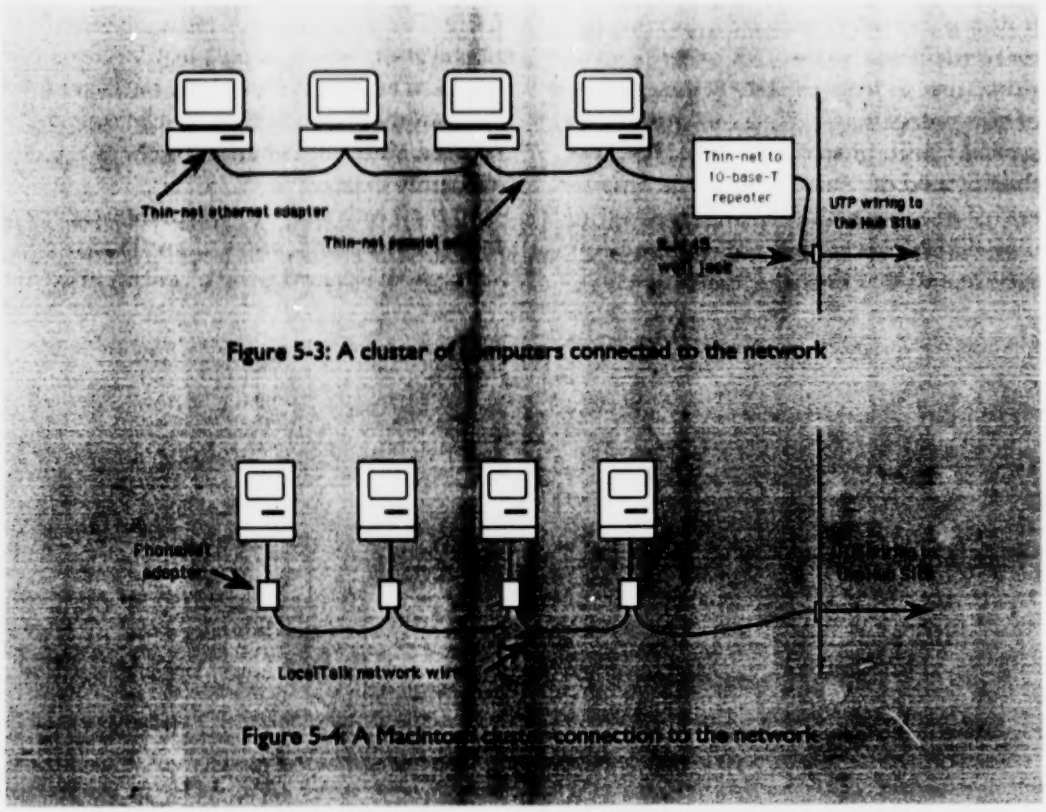


Figure 5-3: A cluster of computers connected to the network

Figure 5-4: A Macintosh cluster connection to the network

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cable to those locations where video may be required at the same time that the UTP premise wiring is being installed. The coaxial cable would terminate on a wall plate mounted "F" connector in the classroom, and would be left unterminated in the utility closet. Future technologies may support video signals over other media so the installation of RG-59 cable should be limited to near term potential requirements.

It will be cost effective to install premise wiring to as many locations as might ever serve a computer. This will include administrative offices as well as classrooms, laboratories as well as libraries. The density of network service outlet locations should reflect the types of use anticipated in a given area. For example, in office areas there should be no fewer than 2 outlet locations and at least one outlet per 150-200 square feet of floor space. In a classroom, there should be outlets near the "front" of the room for the teacher, near the "back" of the room for training and reference areas, and one or more additional outlets for other occasional use. In teaching labs where a cluster of computers may exist, a one outlet may serve a dozen or so computers. However, this method of "daisy chaining" computers off of one service connections requires that all computers have the same type of service and that they share the capacity provided. This will be an undesirable constraint as new technologies become important in the schools.

In some cases it will be cost effective to run multiple cables to the same outlet location. Terminating both cables on the same wall plate will add little to the overall wiring project costs and will add greatly to the flexibility of the system. Premise wiring that is not to be used initially will not be connected to any electronics in the hub site.

Hub sites should be utility closets or other protected, non-occupied areas. Hub sites can be created by construction of small closets or cabinets in low use areas. A hub site must be located within 300 feet of any connection. Typically, multiple hub sites are required in large or multi-story buildings.

Network Distribution System

All hub sites within a school must be interconnected to complete the school LAN. The design of this network distribution system will depend greatly on the physical layout of the school buildings. We assume that ethernet technology will be used since higher speed technology is still quite expensive.

If all hub sites are within 300 cable feet of a central location, then 10-base-T wiring can be used from a central hub to

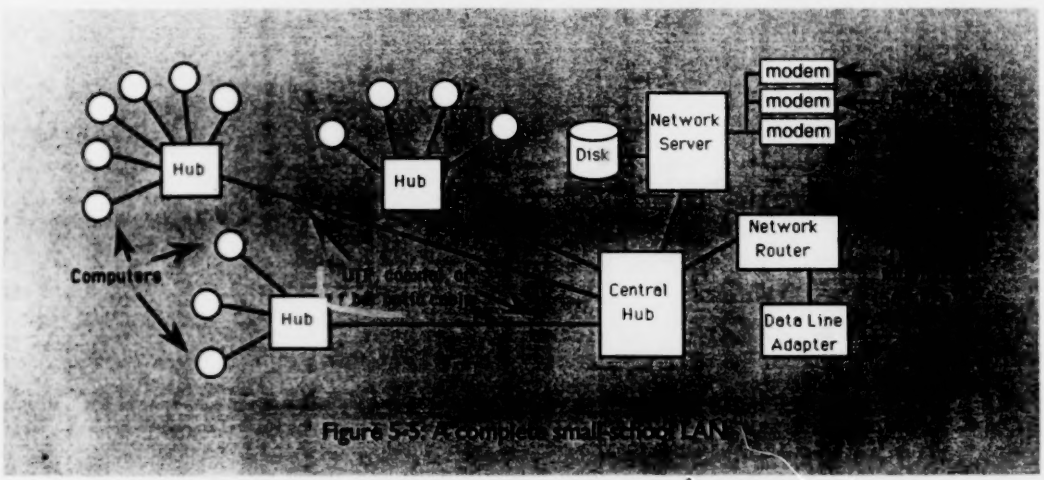


Figure 5-5: A complete small school LAN

connect each hub site, as shown in Figure 5-5. If longer distances are required, either thin-net or standard thick ethernet or fiber optic cabling can be used. Newer, high-speed communications technologies will become important to schools in a few years and will require fiber optic cabling. It is highly desirable therefore to install a fiber optic cable plant as part of the network distribution system now if funding permits.[8] Specific design of the "backbone" network distribution system will depend on the layout of the buildings to be served.

With proper design as many as 250 computers can be connected to a single ethernet segment. Most often the practical maximum number will be much lower than this due to the amount of data sent onto the network by each computer. For planning purposes, one can assume 100-125 computers per segment. Beyond that size the network must be subdivided using "subnetworks." Design of a such a system is not difficult, but is beyond the scope of this document.

The network distribution system cabling should include unshielded multi-pair trunk cabling as well as ethernet trunk cabling. The multi-pair trunk cable will be needed to connect terminals or older computers emulating terminals to a central "network access server" (NAS). A typical NAS can serve from 8 to 128 such connections. It is most cost effective to provide one per LAN, if needed. The NAS connects directly to the ethernet LAN.

Local Network Server

It is highly recommended that each school install a "network server" to support local storage of commonly used information, software, electronic mail, and other functions that may require high-speed communication to the user's computer. Since the connection to the outside network will be much slower than the school LAN, it will be most efficient to access information locally. In particular, software that is to be shared among the school's computers must be stored locally since it would be very tedious to transfer it across the slower external link. The network server will be connected directly to the ethernet network.

The location of the server should be chosen carefully to ensure its protection from abuse and environmental damage. Traditionally the school library is the focus of information gathering and storage activities, and many school libraries have clusters of computers or terminals already installed. The library would be a very logical place to locate the network server computer. The Network Router (see below) might also be located there if a suitable utility space is not available.

The network server will be a small but powerful computer with a large amount of disk storage capacity, typically 1-4 gigabytes. It will run software capable of supporting access by a large number of users simultaneously. It could also support dial-in access from teachers' or students' homes using standard inexpensive modems.[9] The design and functionality of a typical network server is described later in this guide (see Part III, Chapter 6, Network Servers).

External Connection

A single communication circuit will connect the school LAN to the local school district offices. In the school, there will be a Network Router attached between the LAN and this circuit. On the LAN side, the connection will be a typical ethernet cable. On the external side, the connection

[8] If fiber optic cable is installed, consideration should be given to including both multimode fiber for current and future data requirements and single mode fiber for video and future very high speed data systems.

[9] For large numbers of modems, a NAS might prove more cost effective. Also, access control with user authentication is required for this type of service.

will depend on the type of communication circuit used, as discussed below.

Interconnection of Schools with District Offices

All schools within a district should be connected individually to the network router at the school district offices. This "star topology" will be much easier to manage and will minimize conflicting use of the rather low communication bandwidth initially available. As needs change, the capacity of each school's connection can be increased appropriately.

Several standard communication circuit services may be used to effect this connection. The least expensive will be dial-up using high speed modems. However, this type of connection is not recommended due to its very limited speed. Dedicated (permanently installed) communications circuits are strongly recommended since they will allow unattended access to and from the school network at all hours. This will be particularly important if information files are to be downloaded during the night to local network servers. Table 5-2 shows the most common options for dedicated circuit services. The exact costs must be determined by contacting local communications service providers. The equipment needed at each location must also be taken into account in determining total costs.

Frame Relay communication services are becoming available in many areas. Frame Relay is a shared, packet-based data transport service. A school site would contract for Frame Relay service as part of a larger service group that includes the school district office and may include the Internet service provider. All members of that group would share the communications capacity. The advantage of this service is that only one end of the circuit needs to be ordered (each member orders a connection to the common service), and the capacity offered to each member can be upgraded independently. Also, because in many areas the cost of Frame Relay service is not dependent on distance to the service provider, the service to rural schools will be much less expensive than equivalent services. Overall system costs will be minimized since the central router at the district office will need fewer connections.

If Frame Relay is chosen, the overall service group must be carefully engineered. For example, since all schools would share the connection to the district office (and possibly to the Internet service provider), that must be a high capacity

Table 5-2: Short-distance point-to-point communications options

Voice grade leased telephone line.	20 kilobits per sec (Kb/s)	modest[1]
ADN-56	56 Kb/s	[illegible]
ISDN, where available	64 or 128 Kb/s	[illegible]
Low power radio	64 to 256 Kb/s	high initial cost
Frame Relay	56 Kb/s to 1.5 Mb/s	modest to high
TI/DSI	1.5 megabits per sec	very high

[1] Measured service charges must be taken into account.

[2] At this time, most ISDN tariffs include message unit charges, which can make the use of ISDN prohibitively expensive for full-time connectivity.

connection. For the initial design, the aggregate capacity of all school links should not exceed the capacity into the district office (or the Internet service provider) by more than a factor of 3 or there may be noticeable congestion and variability in response times across the system. There are many other factors that must be considered as well, such as the virtual connection topology and how best to connect to an Internet service provider. Therefore, it is recommended that an experienced network engineer be utilized to develop an operational plan for Frame Relay if it is chosen as the school interconnection service.

Future options for interconnecting schools and district offices will include:

- Community Access Television (CATV) cable systems offering either shared or dedicated bi-directional data communication services;
- Metropolitan area fiber optic communications service providers;
- Switched Multi-megabit Digital Service (SMDS) providing data transport service at speeds up to 34 megabits per second; and
- Asynchronous transfer mode (ATM) connection services supporting voice, data, and video communications at speeds into the gigabit per second range.[10]

The costs for the last three options are unknown at this time but may be generally higher than those indicated in Table 5-2. The cost for the CATV option may be negotiable as part of the local CATV contract with the community. As of early 1994, Frame Relay has become available in California. Frame Relay may prove particularly cost-effective in rural areas since the tariff is independent of distance. School network planners should look at the total cost of any solution based on quotes from communications and equipment suppliers in their area.

As demands for network speed develop due to heavy use of multimedia or other bandwidth intensive application, higher-speed communications circuits can replace the initial circuits with little or no change in the equipment or LAN. This gives great flexibility in tailoring service to funding levels and application needs.

School District Office LAN and Support Systems

The school district offices should form the focal point for interconnection of all schools in the district. Within the district offices, network operations can be monitored and problem resolution managed. One or more network servers can provide essential network support as well as central archiving of common information and software.

A critical role of the district office will be to manage Internet "Domain Name Service"[11] (DNS) for the district's schools. DNS is required of all Internet networks. It defines the basic network level identity of each computer, workstation, server, and active network component. This function is described more fully below under Network Management and Operational Monitoring.

The district offices should be wired in a manner similar to a typical school, as shown above. This will allow teachers, superintendents, principals and all school personnel to communicate and share information easily. In addition, a NAS connected to a central pool of modems could provide dial-in access to the district network.

[10] Many more options will become available as new technologies come to market.

[11] See RFCs 1034 and 1035 for a full explanation of Domain Name Service.

Interconnection of the School District with the Internet

Connection of the entire school district to the Internet will take place through the district office interconnect site, as shown in Figure 5-6. This hierarchical model can be extended another level to interconnection of the school district offices through the county office of education facilities. Many administrative information resources could be located at the county level, and there might be cost savings if the entire county connects to an Internet service provider through a single point. The bandwidth required for this single connection, however, will be much greater than that required for each school district since traffic will be aggregated.

This hierarchical topology also provides a logical model for network support and information resource management. The school district or county offices can provide continuous monitoring of the network and provide high level technical expertise for problem resolution, relieving the individual schools of this burden. Interactions with communications circuit providers and Internet service providers will be more effective if handled through a central liaison. Similarly, it is highly desirable that network users have a single well-known point of contact in case they encounter problems or questions (see Part III, Chapter 8: Technical Support).

Internet service should be acquired from the most cost-effective, reliable Internet service provider (see Appendix C). Circuit services can be similar to those shown in Table 5-1. The higher speed services should be considered if traffic demands increase and funding permits. Circuit costs usually will be lowest when connecting to the provider with the nearest "point of presence" (POP), but newer technologies such as Frame Relay and SMDS[12] make circuit costs less dependent on distance. The Internet connection will require a high-quality router that can be configured to interact correctly with the service provider's routers. In most cases, this can be the same router used to support the local school connections.

Integration of Existing School Networks

Many schools have developed LAN systems in support of particular classroom activities or administrative functions. In

[12] At this time, SMDS services are not widely available.

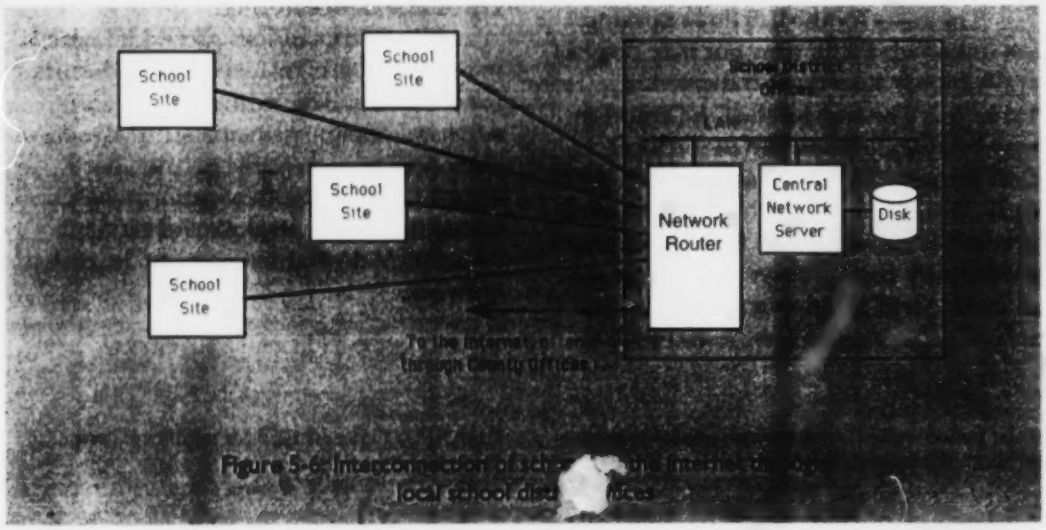


Figure 5-6: Interconnection of school [illegible] Internet through local school district offices

some cases the technologies used are not those recommended for new installations. If these older LAN systems are capable of transporting Internet protocols they may be integrated into a new LAN system and replaced later as funding permits.

For example, IEEE 802.5 Token Ring is often used to interconnect DOS PC-type computers and IBM minicomputer servers. Token Ring networks can transport Internet protocols, and software is available for DOS computers to support basic Internet functions. Many Internet routers support optional Token Ring adapters. This is the recommended way that existing Token Ring LANs can be integrated into a wider school LAN system in order to extend Internet information resources to those PC users.

Another example is a Novell Network system using ethernet as a LAN. The ethernet LAN, if implemented well, is perfectly capable of transporting Internet protocols as well as Novell protocols simultaneously. Each PC or Macintosh can be given software that will allow both Novell and Internet services to be used as needed. This coexistence is important so that, for example, a person using a PC that depends on the Novell server for disk file space can transfer a large file from a remote Internet server to the PC's pseudo-disk. It also permits each user to run client software such as Eudora (electronic mail), Gopher (information services), and Mosaic (World Wide Web information services), which require direct Internet access. To integrate the Novell ethernet LAN into the wider school LAN system, a simple ethernet repeater can be used in a manner similar to Figure 5-3 on page 41.

An alternative to supporting both protocols that is sometimes suggested in cases such as the one cited above, in which a network server already exists, is to use the server as a "network application gateway." This approach is strongly discouraged. It is essential that each computer and workstation support Internet protocol data communication directly so that modern client/server applications can be supported where the server or servers may be located anywhere on the Internet. The "gateway" approach severely restricts the work-station's potential a. ility to access multimedia and other important information resources.

Some technologies, such as "arcnet" (older network technology), may not be capable of supporting Internet protocols but may offer "terminal emulation" shared access to a type of "modem pool." The modem adapter might be rewired to connect to p.rts on a network access server instead. This would provide simple access to information resources for the arcnet users.

In any case, older LAN technologies should **not** be expanded and should be phased out as funding permits. It is critical that there be a relatively homogeneous installed base of technology in order that new applications of information resources can be provided to the entire school community.

Network Management and Operational Monitoring

All networks require some level of network management in order to ensure reliable service. Monitoring of the health of the network can help identify problems before they become detrimental to network users. It also can help predict trends in traffic patterns and volume.

Internet technology network management consists primarily of determining the proper routing parameters for optimal and reliable network operation, assignment of network Internet Protocol (IP) addresses and maintenance of a network-accessible database of node names corresponding to each address,[11] and monitoring the daily operation of the network. The Domain Name Service (DNS) database must be centrally managed although the database

[11] See RFC 1480 for a discussion of Internet naming conventions for school networks.

itself can be physically distributed through the use of subdomains. The primary component of the DNS database for each school district should be located at the school district interconnect site. DNS is discussed more fully under Network Servers in Part III, Chapter 6 of this *Guide*.

Internet network monitoring serves three primary purposes:

1. Constant observation of the "health" of the network, network components, and external network connectivity. Standard Simple Network Management Protocol (SNMP) support is built-in to most active components today. Even network servers and workstations can be monitored in this way. Operations staff can be provided with network monitoring stations that will display alerts immediately upon detecting a wide variety of problems or anomalies;
2. Collection of statistics on the performance of the network and patterns of traffic in order to identify needed enhancements or re-engineering. Using the same SNMP capabilities mentioned above, data on packet forwarding and total traffic volume can be collected and used to generate periodic reports on network utilization;
3. More rapid problem resolution. When problems do occur, SNMP tools can help to pinpoint the source of the problem(s). Such problems include transient routing anomalies, DNS query failures, or even attempts at breaking into network accessible host computers.

Since network management and monitoring is a technically demanding task and requires special equipment and software, it should be a centralized function in the initial design of school network systems, as discussed above. (See also Part III, Chapter 8: Technical Support.)

Summary

The model for school network implementation described above is based on broad experience with this technology in higher education and administrative environments. Many California schools have already installed networks very similar to this model. We believe that it is a practical first step towards bringing a powerful resource to bear for enriching all of California's school programs.

None of the suggestions above preclude or postpone in any way future development of an integrated voice, data, and video network for California's schools. Use of existing Internet carriers does not in any way preclude future development of a separate "backbone" for California's K–12 community if such a "backbone" is determined to be cost effective or required for enhanced functionality. Rather, the infrastructure recommended above can be the foundation at the local level in preparation for future high capacity networks.

6

Network Servers

Introduction

An essential element of the network design will be one or more "network servers." These computer systems provide support for the operation of the network itself and can also provide many important centralized services.

A "server" is, as its name implies, a machine that provides services to others. There are many kinds of network servers in use today. For example, Novell systems include one or more servers that offer common disk space and other useful functions for the cluster of "clients" that are authorized to use them. The network server that must be part of the school network plan provides a set of services specifically for TCP/IP networks and related Internet information services.

The TCP/IP network server should be a fairly powerful computer system with a significant amount of disk space and regular operations coverage, such as file backup and problem resolution. The computer should have a multi-tasking operating system so that it can easily handle many functions simultaneously. It is critical that the operating system have reliable and easy to use Internet support programs. A common platform for network servers of this type is a small to modest sized UNIX-based computer system.

While it is possible to operate a small network with a single server, in most cases a set of distributed servers will be more effective, particularly if the servers are used to store large amounts of information specific to individual school sites. In a scenario such as that it would be more efficient to locate servers at each school site. Furthermore, by distributing the servers it is also possible to distribute responsibility for management of the services and information they support.

A typical system of distributed servers is shown in Figure 6-1. In this

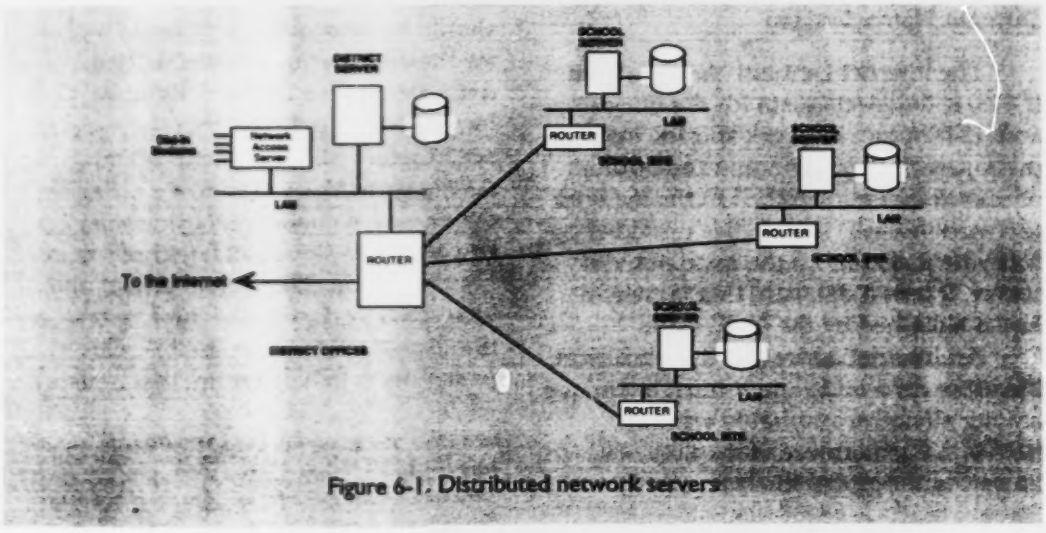


Figure 6-1. Distributed network servers

example, it is assumed that the school district office provides network operations (NOC) support for the entire district and that the connection to the Internet terminates in the district offices.

The discussion of server functionality that follows is divided into three components: those server functions which are essential, those that are very useful, and those that may become useful as use of the network grows.

Essential Network Server Services

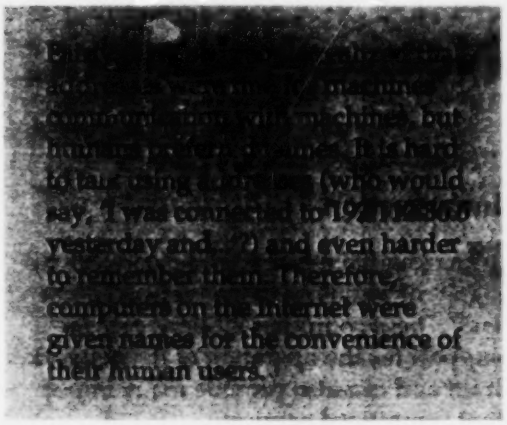
Certain support services are essential to the operation of a TCP/IP network. These include the basic configuration information about the network and information to aid in problem resolution. In general, these services are best supported by a central organization and are most efficiently managed on a central machine. One successful model is to assign support of these services to the Network Operations Center (NOC) group (Chapter 8 provides additional information on NOC).

The following discussion is somewhat technical but is necessary in order to present sufficient detail about these services and the reasons they are so important.

Domain Name System

The Internet Domain Name System (DNS) is the mechanism for documenting and distributing network specific information, including the name and address of each computer attached to the network (network nodes). The DNS is provided by software that runs on the main network server. It uses a database that is created and maintained by the NOC staff.

An Internet address is the numerical identifier for a node and it must be unique among all nodes associated with the network. Furthermore, if the network is to be part of the global Internet, all addresses must be legitimate within the worldwide Internet system.



Associated with each numerical address can be one or more "node names," like goldmine.cde.ca.gov. Although computers have no difficulty remembering numerical addresses, it is often easier for computer users to remember and use the node names. In particular, electronic mail addresses use node names. DNS node names are hierarchical and by appropriately using this hierarchy "subdomains" can be assigned to each school site or district office.[2] In this way, naming can be structured to be flexible as well as meaningful in the context of the whole organization.

A plan for the assignment of IP network addresses and node names should be developed early in the planning for the network installation. Initially the database serving the DNS should reside on the district server so that there is one site at which all assignments are known. As the network grows and expertise is developed, secondary DNS systems can be run on the servers at larger school sites.

The main DNS for the district should be located as close to the Internet connection (topologically) as possible. This proximity is to help ensure that network

[1] Ed Krol, *The Whole Internet*, O'Reilly & Associates, July 1993.
[2] See RFC 1480 for a complete discussion of school domain name conventions.

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problems within the district network have minimal impact on access to the server. This design is illustrated in Figure 6-1; the district server is on an ethernet connected directly to the main distribution router.

Connection Information Database

Associated with the assignment of node names and addresses should be a database of specific information about the computers connected to the network. When trying to resolve problems or answer user questions, it is very important to know where the computers and other nodes are located, what type of computer and software are in use, and what type of network connection is installed. With proper software this database can be used to extract the DNS database discussed above.

Electronic Mail Post Office

A key service supported by the network is electronic mail. Just as the United States Postal Service has post offices that provide essential support services, so must each network have one or more electronic post offices. The electronic post office should provide "post office boxes" for most members of the school community, include an electronic mail "postmaster" who will respond to problems or questions about electronic mail, facilitate electronic mail relay services between the district network and external networks, and provide support services to help ensure that any electronic mail software considered for use is compatible with the overall district and Internet systems.

The most efficient way to receive and store electronic mail messages for a large community of users is to provide that function on central servers. Unlike an individual workstation which may be turned off or unable to respond, a central system can be available at all times to receive mail. In addition, information stored on a central system is more likely to be backed up regularly to secondary storage. A central server is particularly important in a community where a given individual may use different workstations at different times to send or retrieve mail.

Storing messages on a central server does not mean that everyone must use the same software to send and read messages. The mail servers can support a variety of access methods and software, from direct login to the server to distributed "client/server" packages. The client/server model allows the workstation user to perceive messages to be "on his/her local machine." Thus, the human interface to the electronic mail can use the paradigms of the particular computer. For example, the Macintosh interface can use the mouse, icons, and menu boxes while the DOS interface could use command lines and interactive methods more familiar to those users.

The district office server in this scenario would provide a global email directory for all community members and would provide email gateway and relay services for all other district email servers. Each school would still have its own email server where email boxes for each local user would be maintained.

One feature of the central system should be special accounts. For example, the electronic mail "postmaster" is a special account to which questions or problems can be addressed. Staff must be assigned to monitor this account and respond to the issues that arise. Typical problems range from questions about electronic mail addresses to queries regarding bounced mail messages. Other special accounts should be set up for generic functions such as "software" for software related questions or "problems" for general trouble reports.

Electronic mail systems often must modify electronic mail addresses associated with messages in order to ensure that they are accurate or complete. For example, a local postmaster might recognize

the address "ABC Store, 1234 Main Street" even with the city name missing from the address if the store was famous. However, if the store and the Main Street are in another city than that from which the letter originated, the letter will be undeliverable unless more specific information is given. Similarly, if an email message is destined for another user on the same mail server, a simple form of address might be used. However, if the same recipient is to be reached from a distant system, a more complete address including the mail system server's name would have to be included. Therefore, in order to ensure that mail arrives at its designated recipient, a complex set of rules for checking and correcting electronic mail addresses must be configured on each mail server. One of the most efficient ways to reduce the complexity of this management issue is to route all external mail through the main district server where one set of up-to-date rules can be applied to all messages.

A similar function that the main district server can perform is translation of messages sent between different electronic mail systems. A computer program that translates text or data from the form generated by one format to the format required by another program is called an application level gateway. It is called a "gateway" in the network world because we think of "information flow between two worlds." The "electronic mail gateway" is an example of this where the message and addressing format from one system is translated into the message and addressing format of another system. For example, a message that originates on an IBM mainframe computer might be sent in a form that is incompatible with that expected on a Macintosh computer. The district server can be set up to translate these various forms so that recipients are minimally aware of the incompatibilities.

However, because the electronic mail gateway function is a more complex task than merely correcting an address, the need for such gateways should be minimized whenever possible. Before any new electronic mail system is acquired, system support staff should determine if it is compatible with existing systems and, if not, how difficult it will be to create a gateway for it.

Important Network Server Services

The services described in this section are valuable and important but are not required for basic operation of a network. This distinction is useful because it recognizes that these services can be phased in as resources permit.

Community Member Database

Once the use of email becomes widespread, it will quickly become important to have an electronic directory that includes all members of the school community. The need to be able to determine a particular person's address can be served by such a database. This type of database is often referred to as a "white pages service" because it serves a similar function as the white pages of the telephone directory.

The same community member database can be used to seed a user authentication system as described in Part III, Chapter 9 of this guide (Security and Authentication).

Community Services Database

Another type of central database could contain information about services available via the network or support services available to school community members. Questions that could be answered from such a "yellow pages directory" might include, for example: "Who is the network support person at XXX School?" or "Where is the nearest color PostScript printer?"

Central Information Service

One of the most exciting and valuable resources on any network is online information. The ready accessibility of current and important information can greatly improve the operation of any organization. A central directory or information server can be the starting point for locating information within a system of distributed information servers both within and external to the school district.

A number of electronic information service systems are available today. Each has its particular virtues and no one system will be best for all purposes. The general purpose "bulletin board system" or BBS is intended to be used by anyone who wishes to post or read messages. As a result, the validity or quality of information on the BBS can be inconsistent. On the other hand, managed information archives require staff time in order to prepare, install, and validate the accuracy of items for the BBS. The staff time required to maintain such a managed BBS might delay the availability of information.

The netnews system is an electronic bulletin board that has been in operation for more than a decade. It contains thousands of news categories and postings are made from and received by servers worldwide. In fact, the system is so large that the volume of "news" can exceed 50 megabytes per day if all categories are received. Unfortunately, because the system is not moderated there are a number of news categories that are inappropriate for students. (See Appendix E: Acceptable Use Policies.) For this reason schools must carefully select which categories to receive from external sources. Nonetheless, netnews is a very useful tool for posting short items internally and can be used externally to support student and teacher research, professional development, and other educational projects.

The "gopher" information server system has become extremely popular in recent years. Gopher information is stored in a hierarchy that can span many different servers. Thus from the main district server, the gopher directory can point to gopher servers at each school site for site specific information. The California Department of Education will be supporting gopher servers for a wide range of departmental information as well. Gopher is very easy to set up and use, and software for accessing gopher servers is available for most common computers. The gopher software is available at no cost from the University of Minnesota via the Internet.

Most recently, a technology called World Wide Web (WWW) has been developed that promises to support very sophisticated multimedia information on a "web" of distributed servers. Information typically includes hypertext pointers so that a user can jump from one document to a related document by selecting a particular pointer. For example, while looking at a picture of the Cathedral of Notre Dame, a user might select a particular gargoyle and automatically retrieve a description of that icon from a WWW server in Paris. One popular software package used to retrieve information from WWW servers is called Mosaic and is available at no cost from the National Center for Supercomputer Applications via the Internet. Mosaic can retrieve and display complex formatted text, audio, video, and color graphic information on Macintosh, DOS, or UNIX computers. For additional information on these and other services see Part III, Chapter 7: Internet Services.

Dial-in Modem Service

A critical success factor in developing expertise in using the network is access from home. School staff often have little time during the day to concentrate on learning about the network and the resources it provides. It has been demonstrated in several projects that their expertise can be much more readily developed if they can use a modem and computer from home to dial into the network. In

addition, students quickly become accustomed to finding information electronically and will want to do so while doing homework, parents may want to look up the latest school calendar or homework assignments, and administrators may wish to read and respond to their email in the evening or while traveling.

The most cost-efficient way to provide dial-in service to the school district network is to support a central pool of modems for that purpose. Since the network is transparent to applications, any entry point will allow access to all nodes and servers. Thus a central modem pool can provide access to all components of the school network. To be more specific, when you connect to the network in any location, you can reach any other location, barring the presence of intervening security firewalls (see Part III, Chapter 9, Security and Authentication). Dial-up to a central modem pool works because the entry point would be inside any district-level firewall; thus, the caller could reach any computer on the school network without regard to its location.

One cost-effective way to begin a dial-in service might be to have the main district network server provide attachments for supporting a number of modems. However, supporting a large number of such ports can be expensive compared to the use of a special purpose Network Access Server. Such servers can support hundreds of ports with very sophisticated functionality such as IBM terminal emulation or full TCP/IP protocol connections.

A critical aspect of offering dial-in service to the school network is access control. It is considered irresponsible to allow anonymous access to any network and particularly to the Internet because of the potential for illicit or destructive behavior on the part of some people. The community member database described above could be used to support authentication for the dial-in service so that access is granted only to known users (see Part III, Chapter 9: Security and Authentication). Network Access Servers can use this database via software that runs on the main district server.

Network Time Service

A simple but useful service is time synchronization across all network connected computers. A number of systems are available for this purpose. The most sophisticated is the Internet NTP (Network Time Protocol) service that can synchronize itself with very accurate external clock sources and then distribute time data to all local computers.

Additional Network Server Services

There are many more services a network server can support. Included in this section are just a few that may be useful for you to consider when planning your network.

Print Spooling

In order to share printers effectively, it is useful to have a server spool print requests. This allows job control, accounting, and support for a wide variety of printers. For example, a spooler could understand that a PostScript print job would fail on a non-PostScript capable printer and reject the job. Similarly, it could understand that a non-PostScript print request directed to a PostScript printer must have certain information prefixed to the job in order to print. Spooling can also allow different printing systems to share the same printer. For example, a spooling system could enable Macintosh and UNIX systems to share the same LaserWriter.

Print spooling should be a local school site function, however, a local spooler should be able to hand jobs off to another spooler at the district office or

even at another school if documents are being widely distributed.

Products are becoming available that offer many of these functions in a stand-alone unit. Such products should be evaluated against the needs of a particular situation. In general, it should be cost effective to start with spooling on a central server, moving to the stand-alone units only if greater capacity is required.

File Server

A very useful function of a network server is common file storage or file sharing. This function allows users of small computers to have working files stored reliably on a centrally managed system. It also allows many users to share a few large disks and have access to their files regardless of which computer they are using. Common file server systems are Novell, AppleShare, and the Network File System (NFS) found in most UNIX systems.

Like print spooling, it is most efficient to have file sharing be a local school site function. The most useful exception to this is to create a common archive of software on the district level server which local sites can access via file sharing.

Software Archives

Managing the distribution and upgrade of software on a large number of distributed computers can be a very labor intensive problem. A network server can help by providing a place to create an archive of common software. Public domain software could be made available without restriction and access to licensed software could be carefully controlled.

A "network license server" or "key server" is a mechanism for sharing licensed software among a community of related users. The server software runs on a centrally managed machine and keeps track of when a licensed software package is being used. For example, if the school system has license to 100 copies of Microsoft Excel, up to 100 users would be allowed to use the software simultaneously. The 101st person would be told to try again later.

Example of a Multi-purpose Network Server

An example of a multi-purpose network server is the BBN Internet Server, previously known as Copernicus, developed by Bolt Beranek & Newman Inc.[3] and used in the NSF-funded National School Network Testbed project. This Unix-based server is designed to support Internet-standard electronic mail, netnews, gopher, World Wide Web, common file archiving, and other services that can be accessed from desktop applications. An easy-to-use Macintosh application has been developed to allow users, without a high level

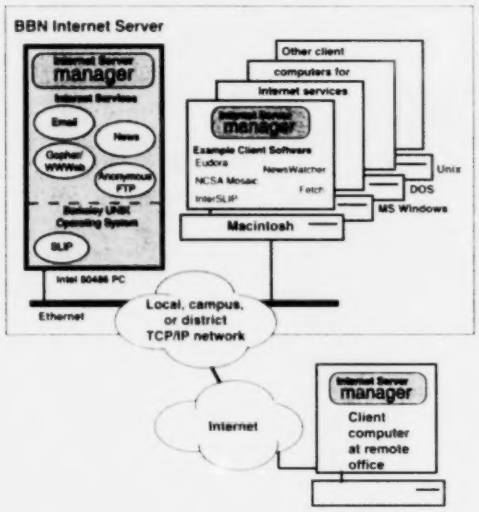

Figure 6-2
Example of a multi-purpose network server

[3] Contact Karen Nelson, Educational Technologies Department, Bolt Beranek and Newman Inc., 150 Cambridge Park Drive, Cambridge, MA 01238 for more information or send email to server-info@copernicus.bbn.com.

of expertise, to administer and manage the resources on the server. The California Department of Education is participating in the test bed to determine the ease of use in disseminating Department information to schools.

Conclusions

A network installation plan must include at least a basic network server to support certain aspects of operation of the network. The same type of computer platform can also support a wide variety of other very useful services. As use of the school network grows and new applications are developed, functions can be added to the existing servers or new types of servers can be added. Planning for this support function now will position the district to move more readily to embrace new opportunities as they arise.

Chapter 7

Internet Services

Introduction

One sure indication that a technological innovation is becoming "mainstream" is its debut in editorial cartoons. Yet although satirical glimpses into the impact of the Information Superhighway have arrived, even savvy political pundits are demonstrating little foresight into what new services will hurtle down the electronic pike into our homes once this infrastructure is in place. The prospects of a 12,000 player Mario Brothers and interactive Oprah in the living room may produce laughs (and anxiety), but the ultimate uses of this technology are still, to a large extent, based upon imagination and speculation.

Nonetheless, access to the activities and services already available on the Internet (and some of those which are currently under development) propel today's schools into an information age environment which, when compared to the resource drought in the average classroom, seems almost futuristic in its abundance.

While this section discusses Internet services, the local area network in a school can provide specific services to the school community as well. For example, commonly used software can be stored on a file server so that users can have access to the most current version. Common documents or school bulletins can be stored on a local server for general access. Printers can be shared by connecting them to the network or to a file server on the network. These types of services will be specific to the network software chosen for your school and should be considered when evaluating the benefits versus the costs of implementing a network.

The focus of this chapter is on the tools which facilitate access to information beyond the school's domain— on the Internet. The network services we will discuss fall into two general categories: communication and messaging tools and resource location tools. Communication tools include electronic mail (email), USENET News, and Chat and Talk. These tools allow users to communicate with one another over great and small distances with varying degrees of direct interactivity. Resource location and retrieval tools, such as File Transfer Protocol (FTP), Telnet, Gopher, Wide Area Information Services (WAIS), and World Wide Web (WWW), allow users to access and utilize information and resources which reside on distant computers.

Communication and Messaging Tools

Communications made available through the Internet vary in scope and functionality. Electronic mail is a powerful tool for one-to-one communications and for joining into discussion groups where several people at a time share and respond to messages. USENET News is a similar tool for group discussions which involve experts and non-experts alike on many topics. Finally, Chat and Talk are tools that allow interactive one-on-one and one-to-many communications.

Electronic Mail

Electronic Mail (email) is essentially electronic correspondence. Email is initiated from a single user and allows the author to communicate with any of the

other ten million users on the Internet - and for that matter many other networks. Email can be addressed to an individual or to groups of any size.

Use of email is exponentially increasing as more and more individuals and organizations acquire access to networks. In addition to offering a time and cost efficient means of communication, email is a catalyst for encouraging exploration of ideas and interests between people who are not, and may not be able to be, personally aquatinted. Countless informal and formal dialogues are taking place between individuals who share professional and personal interests but who are separated by location, profession, age, and other characteristics which are easily overcome in the information age. The ease of connecting people who have been isolated in the past is literally transforming the way in which many people approach their daily work. For example, teachers whose students have access to email are able to facilitate conversations between their students and working professionals around the globe, encouraging design of inquiry-based, collaborative, problem-solving curriculum.

Listservs and Mail Lists. An important aspect of communications through email occurs through group conversations, called listservs or mail lists (and USENET News, which is discussed below.) Learning and teaching communities are springing forth as more and more people participate in these flexible and convenient forums. Listservs and mail lists are email conferences which allow users to join interactive discussions with groups of people, both small and large. Listserv and mail list conversations focus on an extremely broad array of topics and range from relatively formal, quality controlled or 'moderated' discussions, to highly informal meeting grounds.

USENET News

USENET News offers the same basic service on the network as do listservs and mail lists. The primary difference is its delivery mechanism. Mail lists and listservs are initiated through email. News group conversations, as they are often referred to in USENET News, are delivered via a separate mechanism (not your email account) and are accessed by using a different set of commands. The benefit of USENET News is that your personal email account remains uncluttered even though you may be involved with several different discussions. If you do not have time to read the information that has arrived via your news group, the information will eventually be removed from the system; news groups free you from the responsibility of managing each and every message as you do with your email.

Currently, there are between 3,000 and 4,000 news groups (the number of groups is increasing). News groups range from highly technical discussions (e.g., space physics) to informal conversations (e.g., bonsai care, recipes). The degree to which the discussions are formal is often determined by whether or not the group is moderated. In the case of a moderated news group, all correspondence to the group is passed through the moderator, the same is true of listservs and mail lists. This person ensures the integrity of the contribution. If the message is deemed of value to the whole group it is posted. Otherwise, the sender may be directed to send an email to a specific reader or to try posting to a different news group. USENET News offers a unique vehicle through which participants can ask specific questions, gain insight on specific topics, and obtain detailed information from others about where to look for more information on topics of interest.

Chat and Talk

Chat and Talk are the Internet services which most resemble using the telephone to communicate. Unlike email, listservs and mail lists, users of Chat and Talk must all agree to be on line at the same time. Once the initial communication is estab-

lished, they can all participate in a truly interactive conversation. As each member of the discussion types in communication, all other members view the words on the screen along with a tag identifying from whom the communication is coming. The difference between Talk and Chat is that the Talk utility allows only one-to-one communication, while Chat allows a group of users to simultaneously participate in the conversation.

Like other communication services mentioned, the formality and purpose of this type of communications can vary a great deal. The conversations can be loosely defined by a very broad subject heading or limited to the consideration of a narrowly defined topic. This type of communication takes planning and coordination but can be a very effective tool allowing teachers and students to participate in highly interactive conversations across great distances.

Resource Locator and Retrieval Tools

As recently as two years ago the Internet was referred to as a library with no card catalogue, a gourmet restaurant with no menu. The user had to know the site where a file or document resided (usually learned through conversation with someone in a newsgroup or on a mail list) in order to find it. This is still true of the first two tools we will discuss, Telnet and File Transfer Protocol (FTP); but as you will see, it is no longer true of all retrieval and access applications. Thanks to the efforts of Internet users around the world, easier-to-use search tools are now available which save you both time and energy. The search tools in this category which have been widely used to date are Gopher, Wide Area Information Servers (WAIS), and World Wide Web (WWW).

Telnet

Telnet (may sometimes be referred to as login) offers users the ability to log onto a distant computer and have a real-time interactive session on it. A user engaged in a telnet session can access databases and search for relevant records, have real-time conversations with other users, and select menu items leading them to information "trees" which provide more in-depth information at each level.

The manner in which information on a telnet site is presented can vary a great deal:

A telnet site can be configured to operate like a data base. The user enters a topic and the system responds by presenting the user a relevant set of records which contain information pertaining to that topic. For example, Education Research Information Center (ERIC) is a telnet site which provides information on educational research conducted worldwide. ERICusers can enter a topic (e.g., choice and vouchers) and will be directed to a list of papers which contain information on that topic.

Archie. Another popular use of telnet in the database format is referred to as Archie (the name comes from the word archives). The user telnets to an Archie server and enters a key word (as opposed to a topic). In response, the Archie server provides the user a list of FTP sites and file names containing that key word. (More will be said about FTP in the following section.)

A telnet site can also present information much like a bulletin board. Available topics are listed menu-style and the user chooses from among them. For example, NASA Spacelink is a telnet site which offers a variety of information for teachers on topics such as shuttle launches, Mars explorations, and other space related research and activities. The user of a telnet site configured in this way need not know the specific topic to be researched ahead of time. This can be particularly useful for students who are asked to choose a narrow topic of research in a broad field of study.

MUDS. Finally, telnet sites can be configured as Multiple User Devices (MUDS). This configuration allows for chats to occur and grants simultaneous access to multiple users so that those users can participate in real-time, interactive sessions on a single system. Most often with these telnet sites, users are engaged in a predefined or preconfigured environment. Uses for these systems vary from text-based, virtual reality systems (e.g., MIT's MicroMuse) to online gaming systems.

File Transfer Protocol (FTP)

A very common way to retrieve documents, images (photos, graphics or animation), and applications via the network is through a service (actually an application protocol) called File Transfer Protocol (FTP). In essence, FTP offers the individual user the ability to use his/her computer to access and retrieve publicly available files from another computer on the network. In other words, the individual can access a directory, or list of file names, on a distant computer, select one or many of the files and have them transferred to his/her own computer. These files can then be read and manipulated as if they were his/her own files (barring any copyright restrictions).

> Ed Krol describes FTP: "Often, you will find information on the Internet which you don't want to examine on a remote system: you want to have a copy for yourself. You've found, for example, the text of a recent Supreme Court opinion, and you want include pieces of it in a brief you are writing. Or you found a recipe that looks good, and you want to print a copy to take to the kitchen. Or you found some free software that just might solve all your problems, and you want to try it. In each case, you need to move a copy of the file to your local system so you can manipulate it there. The tool for doing this is FTP.
>
> FTP is a complex program because there are many different ways to manipulate files and file structures. Different ways of storing files (binary or ASCII, compressed or uncompressed, etc.) introduce some complications, and may require some additional thought to get things right."[1]

Gopher

Gopher is an Internet application made up of many network servers which "burrow" through the Internet on your behalf in search of pertinent resources. The resources accessible via Gopher are vast. For example, Gopher servers will locate images, applications, files, news group archives, and, if your search leads you to it, Gopher will even establish a telnet session for you. The value of Gopher is that once you have selected menu items representing information that interests you, Gopher establishes the necessary network connections to get you to the resource. Another feature of Gopher is that unlike FTP, Gopher allows you to actually read a file before deciding whether or not to save it to your computer. (Wide Area Information Services and World Wide Web below also include this feature.)

For example, imagine your students are studying weather patterns and are using Gopher as a tool to help find resources. By using a tool within Gopher called Veronica, students are able to perform a word search and locate resources on any Gopher server. Such resources might include European weather satellite images updated hourly, meteorological documents, or NASA satellite photos of

[1] Ed Krol, *The Whole Internet*, O'Reilly & Associate, Inc., July 1993.

hurricanes. Should your students decide they want to copy some of these resources to the classroom computer, Gopher will also manage the transfer of those resources. These resources may be located on many different servers, but thanks to Gopher your students will be seamlessly escorted from one computer to another so that they can concentrate on the resources themselves rather than the logistics of data location and transfer.

Wide Area Information Services (WAIS)

Similar to the Gopher tool Veronica, WAIS allows the user to perform word searches of documents residing on over 450 network servers nationwide (in fact, some information is available through both Gopher and WAIS). WAIS servers, referred to as sources, are topic-specific systems containing indexed information. Many of the sources store archives of Frequently Asked Questions (FAQs) resulting from USENET News group discussions. Other sources contain information that would otherwise be found in a typical data base or card catalog.

WAIS, like Gopher, is an excellent way to find information on specific topics. Unlike Gopher, WAIS allows you to keep your search limited to specific servers. Over time, a WAIS user can become very familiar with the sources that produce the most pertinent results and can save time by limiting his/her search to those sources.

World Wide Web

World Wide Web (WWW). This is yet another information locator tool on the Internet. The innovation with WWW is that information is presented in a hyper-text format. What this means is that key words in the document are linked to background and supporting information which can enhance the user's understanding of the topic. Hypertext links lead the user to other text documents, images, sound files, and even movies. The user only need select the key word and WWW leads him/her automatically to these related resources.

Mosaic. It is common to hear WWW referred to as Mosaic. However, Mosaic is really the interface which is becoming the standard for using the WWW tool. Mosaic provides a user-friendly, graphical interface into the hypertext format in which the information in WWW is presented. The value of Mosaic is that it makes using WWW even easier and is therefore contributing to the growth and popularity of the tool.

In *The Whole Internet* Ed Krol states, "Hypertext is a method of presenting information where selected words in the text can be 'expanded' at any time to provide other information about the word. That is, these words are links to other documents which may be text, files, pictures, anything."[2]

Cello. A recent newcomer to the Internet is a WWW client called Cello. Cello is a multipurpose Internet search tool which permits users to access information from many different sources existing in varying formats. This means that Cello can be used to access data from WWW, Gopher, FTP, WAIS servers and many others. The Cello client will also attempt to decode the file or information being retrieved as long as it recognizes the compression scheme or application used to modify or create the file. As you can see, Cello is a highly flexible tool, and as the Internet matures as an information and communications resource, it is expected that many more such tools will be developed and adopted.

Conclusions

It is important to remember that the Internet is not managed by a single source, nor is its future determined by one

[2] Ibid

special interest group. Therefore, use of the network and the tools which facilitate that use are being developed on an ongoing basis by groups and individuals worldwide. We have discussed several of today's most prominent communication and search tools. These tools are continually evolving; and though they are the most well used today, tomorrow's innovation may bring completely new methods for locating information. The Internet is a tool for lifelong learning, and users of the Internet should be prepared to discover and utilize new tools as they become available.

8

Network Support

Introduction

The image of an Information Superhighway recalls the success of the Interstate Highway Program which at mid-century efficiently linked remote areas of the country, contributing to decades of prosperity. Yet as is true of most metaphors, the highway comparison obscures some of the major differences between asphalt and electronic paths. The periodic patching of ribbon asphalt is a far cry from the continual management needs of network facilities. Similarly, mass produced, easy-to-use road maps bear little resemblance to the support and training teachers, students, and administrators will need as their schools and districts are networked to the world.

Highways rely on trained teams of specialists to repair potholes, remove roadblocks, and redesign areas in which bottlenecks occur; networks depend on trained personnel to address their needs as users increase in number and the operations they perform become increasingly complex.

In order to truly take advantage of a communications superhighway, schools and districts must be prepared to provide properly trained personnel to keep the networks running smoothly and to help users properly navigate their routes. This vital support function is called "Network Support" and is composed of two major components: The Network Operations Center (NOC) and the Network Information Center (NIC) for user support. The NOC may be staffed by one part-time person or by many individuals. The number of support personnel will be a function of many variables, including the size of the network, its complexity, and the level of support desired for users.

Network Operations ensures that the technical tools of the network are properly in place and are kept running efficiently. This function involves making sure that the hardware and software elements that make up the network are functioning well. Typical questions NOC personnel ask and answer are, Is access to the Internet consistent and reliable? Why can't I get to the ERIC gopher? I can get to the district office just fine, but how come I can't get to the CORE server? Why is response from the CSIS server taking over a minute? If the NOC also handles issues of local area network support, they may be asked questions such as, Do the desktop computers have enough memory? Why is the printer response time slow? Why is the server responding slowly?

User Support, through the NIC, on the other hand, is more concerned with helping users utilize the tools that will assist them with access to the resources on the network. User support provides users the assistance and training they need to take full advantage of the network's capabilities. How do I use email? Can I create my own bulletin board? Can I email a spreadsheet to someone in another district? These are the types of questions user support personnel are asked and answer.

Thus far, Network Support may sound like a discussion of how to manage technologies, but it is also a discussion about people. An organization that implements technology but does not address Network Support as both a technical and

personnel issue will soon find itself in trouble. Likewise, organizations that try to glance over network support issues with superficial solutions will be no better off. For example, in many schools, network support issues have been the responsibility of an existing staff member who has been a champion of the technology and who agrees to support the network in addition to his/her other responsibilities. While this may be effective in the short term, it has proved to be ineffective in the long term. As the network inevitably expands, the number of persons requiring training and support increases, and soon the part-time network support person finds him/herself torn between the priorities of his/her "real" job and the responsibilities of managing and supporting the network. Therefore, while it may not be necessary to assign a full-time network support position in the network's earliest days, it is critical that long-term and ongoing support issues be discussed and planned for from the beginning.

This chapter will seek to clarify the role and responsibilities of Network Support personnel and will discuss the staffing issues for theses vital functions.

Network Operations Center

The person(s) assigned to handle Network Operations will seek to manage issues of access to the network and ongoing operations. The primary responsibilities of the Network Operations personnel will be to:

- Monitor the health of the network by collecting statistics, and monitoring traffic levels and congestion reports;
- Configure and maintain the active elements in the network such as routers, hubs, modems, etc.;
- Work with vendors and suppliers, Internet access providers, the local telephone company, and others to resolve problems and order new equipment and service enhancements;
- Assist users who are experiencing technical problems sending electronic mail or reaching resources outside of the local area network, such as a remote printer or file server;
- Resolve network-level communication problems by ensuring that users can access all of the other networks they need to reach in order to accomplish their work;
- To the extent possible, assist users whose needs may go beyond those the network currently supports.

Network Size

At first glance network size may seem like a very simple issue: the bigger the network the more people needed for its management. However, the relationship between network size and support staff is not that simple. It must be carefully considered and is often only determined over time. One of the most important factors that will determine size of support staff relative to the size of the network will be the ability to automate and simplify management and administrative tasks. There are software tools that allow for the centralization of specialized staff for network management and administration, thus allowing the costs for this function to be shared across districts or counties, reducing the number of dedicated support staff at each network location.

A significant tool available to a NOC today is network management software. Network management programs can perform real-time monitoring of local and wide-area networks. These tools alleviate the need for an individual to constantly monitor all aspects of the network. These programs range in sophistication, with those at the high end producing graphic displays of network performance, logs of network events, usage patterns, and, in the event of a breakdown in the system, "trouble tickets." The standard for network management tools for the Internet is the Simple Network Management Proto-

col (SNMP). Network devices should be purchased that support this protocol to ensure the NOC staff will be able to use network management tools and lower the cost of network support.

Other duties that can be made easier through the use of a network management program are the network administration tasks. As the network grows in size, these tasks will no doubt grow in number. Assigning domain name addresses to each system that is brought online is one example of a critical administrative function that can be well supported through the use of network management software (see Part III, Chapter 6, Network Servers).

In addition, the use of a sophisticated monitoring and management system allows NOC staff to quickly detect problems and sometimes even predict them before they occur. With the right level of automation, a small staff can manage a large network by having streamlined management procedures for bringing on new users and devices. In addition they are better able to reconfigure or upgrade the system before users become dissatisfied or are unable to use the network all together.

Network Complexity

A second factor which helps determine the character of the NOC is the complexity of the network. From a support perspective, the network's complexity is determined by the number of disparate pieces of equipment on the network. Complexity of support decreases when the number of vendors are minimized, protocols and equipment are standardized, and desired levels of support are determined in advance.

The ability to work closely with vendors allows the NOC staff to develop more stable working relationships with those vendors whose equipment is selected. These relationships can be critical to solving problems during a crisis and to the planning of network expansion. A trusted vendor who has insight into the organization and its needs can assist the NOC in making future purchasing and support decisions. Without this relationship, the NOC may find itself receiving minimal assistance from vendors during times of need or growth.

Standardization, to the extent possible, is also extremely helpful to the NOC. NOC personnel must be trained and up-to-date with every item of equipment supported by the network. The less time NOC personnel must spend familiarizing themselves with new equipment, protocols, and software, the more time they can spend ensuring that the quality of support they provide is first-rate. Further, since budget constraints are most likely an important consideration, a smaller number of people can become intimately knowledgeable about a well-designed standardized network, resulting is lower personnel costs while maintaining a knowledgeable and qualified support staff. The level or degree of support may be compromised, but not the quality.

Desired Level of Support

An important consideration when determining the nature of the NOC is how fast problems should be solved in order to maintain efficient operations within the organization. For instance, problems may be most quickly addressed if support staff are located at each site. Problems such as a loose printer connection, a bad memory chip, or defective software can be effectively handled by minimally trained, relatively non-technical personnel. However problems such as a badly performing router, a misconfigured server, or a poor circuit connection are better suited for more technically trained personnel located at a centralized NOC. A two-tiered approach is recommended, with a county or district sharing the costs associated with employing relatively skilled network support personnel, employing less-skilled

personnel to manage local issues on site within the school.

In order to ensure timely service to even the most remote LANs, each organization should assign local area network administration duties to on-site personnel. This person(s) would be capable of solving local problems in a timely manner, relying on the centralized NOC staff only when assistance is required to solve complex or unusual problems.

Staffing

In most schools and districts, an existing staff member, such as a librarian, administrative support person, teacher, or even student can be trained to manage the day-to-day operations of the LAN(s) and serve as liaison to the NOC. In this scenario, troubles with the network are first reported to the on-site personnel. If the problem proves to be beyond the capacity of the local personnel, a service call is placed with the centralized NOC. (Even if a local support person is not assigned, a single liaison to the NOC is critical for efficient communication between the two organizations.) It is very important to note that all issues and troubles arising with the local LAN must be reported to the NOC, even those that are resolved without assistance. Without this communication the NOC may miss vital information which could have an impact on future planning and management of the network.

The more intricate or technical issues handled by the centralized NOC personnel will generally require highly skilled employees. NOC personnel often have two- to four-year degrees in a technical field, such as computer science or an engineering discipline. However, it should be emphasized that in the area of network management, experience with networks and the network technology may be the best prerequisite for the job. Proven ability to work with technology and people, solve problems, and be sensitive to end-user concerns are important qualifications for NOC personnel.

User Support

The title given to an organization, group, or individual providing user services is the Network Information Center (NIC). The NIC often provides what are called help-desk services, including, but not limited to: questions about the use of the network, "hand-holding" for users whose experience with the system is limited, initiation for new users, training in new tools and applications (Training Issues), and questions about useful resources to be found on the network (Resource Issues). NIC services can be provided at the school, district, or county level.

Personnel performing the NIC function may be required to provide the initial training on the uses of the technology and/or provide ongoing support as resource experts. As trainers, they will help users overcome technical and non-technical obstacles to becoming proficient users of the tools available on the network. As resource experts, they will guide users toward the tools and information that can assist them in their work.

Training

Training will be discussed in detail in the Chapter 10. However it is worth noting that the most important characteristic of a responsive NIC is flexibility. In order to design relevant training, NIC staff must be knowledgeable not only about the tools of the network but also about how the users will be wanting to use those tools. Training will differ for users with technical backgrounds and those without, for those who fear technology and those who are adventurous; but for all users, hands-on training must be at the core of support.

The NIC staff should also be prepared to serve as ongoing consultants to

those they've trained. New technology and tools should never be introduced without customized training and periodic consultations with users. This is the most effective way to ensure that each user is maximizing his/her potential use of the resources located throughout the network. Whenever possible, training should integrate issues of curriculum development, assessment, and collaboration so that new users can be assisted in integrating the tools of the network into meaningful classroom activities.

Resources

As with the NOC function, NIC responsibilities can be assigned to many different people whose responsibilities vary. Local NIC staff may include librarians, teachers, administrative support personnel, and students. NIC resource personnel should be well versed in the networking interface tools and the types of services available on the LAN and the Internet. The primary goal in this function is, to the extent possible, to be available to assist teachers and students in their search for relevant resources.

As users require the need to communicate with other persons and locate resources on the network, NIC personnel will assist them. For example, if a student is doing research on China and would like to use the network, a NIC staff member might demonstrate how to use the USENET News function and help identify the conferences that may hold discussions relating to China. If the science teacher would like to find information on the latest Mars research, the NIC staff would assist in the location of Mars-related images, documents, and specialists on the Internet.

Staffing

The personnel in the NIC staff may not be required to be as technical as those performing the NOC function. However, it is critical that the staff members be patient, competent communicators. The ability to become familiar with the technology is only one part of the task. NIC personnel must be able to listen to user needs and pose working solutions. At the same time, they need to be able to explain to a user the reason certain requests may not be accommodated, and for this they will need certain technical competencies. Staffing considerations for the NOC may include the following positions:

Postmaster

Every organization which uses electronic mail should have an Electronic Mail Postmaster and a mailbox postmaster, for the receipt of messages regarding use of the electronic mail system, mail problems and general inquiries about reaching people within the organization. The Postmaster is responsible for reading postmaster mail and responding to inquiries. These duties can be performed by non-technical staff, with forwarding of messages to the appropriate technical support person as required.

Campuswide Information Systems (CWIS) Administrator

Campuswide information systems or bulletin boards are one of the most useful applications on the network. These systems allow people to share timely notices, documents, and other resources with large groups of people. These systems typically provide a hierarchical or tree-like structure of menus that lead to online documents or other services. Common types of information include deadline notices, grant announcements, training schedules, and lists of available resources, such as videos in a library or reference materials.

A CWIS, bulletin board, or gopher must have an administrator or sponsor to oversee the design and maintenance of the system so that it is easy to navigate and find information, provide a professional presentation of information, and ensure that information remains timely and

relevant. This function can be performed by NIC staff or trained librarians or administrative staff as appropriate.

Management of Online Conferences

Online conferences provide a way for groups of people to share information, discuss ideas, and pose questions. Conferences usually are set up to serve the needs of a group of people sharing a common interest. For example, an online conference might be established for teachers to discuss a new science teaching framework or a teacher may establish a conference for the discussion of the Civil War as part of an American History class. Some conferences are ongoing and may exist for years. Others are short term and may exist for only one semester. Conferences may be created using the electronic mail system or USENET News (as described in Part III, Chapter 7, Internet Services).

NIC staff must also be willing and able to work with the NOC staff in order to effectively plan for the growth of the network. The knowledge and experience of NIC staff are very important when plans are developed to upgrade or expand the network. These individuals will know better than anyone how the network is being used, what needs are being met, and what services have been requested that could not be accommodated. As they contribute this information to the planning process, the usefulness of the network is more likely assured.

Additional Staffing Considerations for the NIC and NOC

As discussed at the beginning of this chapter, the decision as to who will perform the NOC and NIC functions of Network Support is a critical one. The first decision that will have to be made is whether or not a dedicated staff person(s) will be assigned these responsibilities. As mentioned before, it is common for organizations to assign a part-time person to a support role when the network is first introduced. However, the implications of this are many. The first is that as the network grows, the support staff's priorities will likely become conflicting. Users who cannot receive immediate assistance will be angry and frustrated. Yet if the support staff is composed of teachers, response time will always be constrained by classroom responsibilities. Second, NIC and NOC staff who perform multiple jobs are quick to report "burnout" and dissatisfaction with their own performance.

Finally, once staff have been assigned, it will be equally important to address coordination of services at the school, district, and county level for the purpose of ongoing support and planning. Individuals at each of these levels must converse with one another on a regular basis in order to share information, avoid overlapping trouble-shooting, coordinate growth and expansion, and ensure that the networks in their region remain compatible with both state and national long-range planning.

Chapter 9

Security and Authentication

Introduction

One of the most important aspects of creating a network is securing the applications and the data that they contain. Securing networked resources involves preventing unauthorized access to the networked systems and resources—whether or not the threat comes from users sitting in front of systems on your own network or from remote systems or users seated at those remote systems. This chapter of the planning *Guide* addresses techniques and technologies which facilitate securing your networked applications and data. The solutions discussed will begin with a review of the most simple and straightforward protection methods and end with an overview of the more state-of-the-art techniques which are available today.

The task of securing your networked resources from unauthorized access may seem a daunting task to the potential network developer. However, we want to emphasize that network security issues are effectively dealt with every second of every day. As with the other aspects of network planning discussed in this *Guide*, network security can be planned for, prepared for, and integrated into your overall network plan so that you can avoid the vast majority of problems before they occur.

There are three primary elements to consider when securing computer networks that manage school records and financial data and allow Internet access to and from the classroom. The first is to prevent unauthorized access to the systems on your network; this is accomplished primarily through user education and effective use of passwords. Second, it is also important to go a step further and to take measures to protect the information on your systems, as it resides on your systems and as it traverses the network; this is done primarily through system and network configuration methods and encryption products. Finally, authentication schemes are a critical element to the ongoing protection of your applications and data.

Preventing Unauthorized Access to Networked Systems

Most unauthorized access to network resources stem simply from lack of user awareness of the issues involved in keeping networked resources secure. In order to eliminate these avoidable breaches, users must be made aware of what security is and how their actions may deliberately or inadvertently contribute to problems. We cannot emphasize strongly enough that education regarding security issues should be addressed as soon as access to the network is granted, not after a problem has occurred.

User Education

Network security education should begin with a general discussion regarding the interdependence of all users on the system and the ethical/moral obligation each user has to protect the system.

Second, clear definitions should be provided to users explaining the differences between those resources which are publicly available and those that are proprietary. Third, user education should strongly emphasize the legal aspects of security. The penalties involved in illegal or unauthorized access to resources available through the Internet or any other network should be clearly defined and users should be made aware (regardless of their ages) that these penalties will be enforced. Examples of acceptable use agreements between users (teachers, students, and parents) and the network administrator are provided in Appendix E — Acceptable Use Policies.

Passwords

Another important aspect of security education is an explanation to users of the role played by passwords (both to their accounts and to other restricted resources on the network). A surprising number of security breaches are the result of poor password selection and control. Adequate password security will include consideration of the following:

- Users should be instructed never to give their passwords to others (no matter how tempting it may be in order to demonstrate how wonderful access to the network is);
- Users should be asked to select passwords which are random in nature as opposed to those that are easy-to-remember such as a partner or spouse's name, a child's name, anniversary dates, and others that are easy to guess. Selecting nonsense passwords containing capitalization, punctuation, and digits (e.g., 2guD-4u) can help prevent "guesswork" break-ins and dictionary attacks where the hacker tries all the words in a special dictionary.
- Often new user accounts are established using a default password. Each new user should be required to change this password upon first logging in. If this is not required, many users will use the default password indefinitely providing easy access to any user who already has seen the default. (Assigning initial cryptic passwords may be a solution to this, but it is often considered bad security for even the system administrator to know user passwords). Network servers should be configured so that users are required to change their passwords on a regular basis (e.g., every three or six months).

Protection of Networked Information

Protecting access to sensitive information on a network takes on a more critical nature as many districts and counties are integrating their administrative and instructional networks. Many districts and counties have networks in place which transfer school administrative and financial data among geographically separated offices. By connecting the Internet server to these existing networks, the bandwidth on the administrative network can be shared and used to transport instructional materials to the classroom. Because approximately 80% of the costs associated with owning a network are the recurring monthly circuit costs, the sharing of bandwidth is highly desirable. Nonetheless, it does introduce greater security risks to the data on the networks and requires judicious attention to the task of preventing unauthorized access to the educational community's highly sensitive administrative data.

The primary issue when protecting networked information is preventing unauthorized access to data and user accounts. Whether the potential threat originates from a user at a system physically located on your network or from a user sitting at a remote system, there are measures that can be taken to minimize the likelihood that a "break-in" will occur:

- Establishing user access privileges;
- Creating a "Firewall"; and
- Utilizing encryption software.

Establishing User Access Privileges

One step toward protecting systems is to compartmentalize user access to applications and data stored on networked computer systems, (e.g., protect the users from one another so that one user cannot damage the applications or data of another). Most multi-user systems allow restrictions to be placed on individual files and applications. These restrictions can allow various levels of access. For example, one restriction might specify that a select number of users have the right to modify a file, other users can only read it, and others might be restricted from even reading its text. A system administrator who ensures that access privileges are properly set has taken a major step to prevent unauthorized access to files and data.

Creating a "Firewall"

Physically configuring the network in a manner which restricts access is a popular way to protect sensitive data on a network. This typically is accomplished by using a dedicated router which functions as what is referred to as a packet filtering "firewall." This firewall router acts as a trap door to permit only desired traffic (e.g., requests from known systems) to cross while discarding undesired traffic (e.g., packets from a hacker trying to gain access). A firewall can make it appear that your internal users have virtually unlimited access to the Internet and its resources while making your network appear to be a "black hole" to undesired or unauthorized hosts in the Internet.

A packet filtering firewall first examines the source, destination, address, and program information in each packet. It then applies a set of rules which have been created by the network administrator. These rules determine which packets may be passed onto the network and which packets should be discarded. It is possible to create a set of filter rules that permit general access only to specific systems while permitting other, predetermined sites to have greater or lesser access. It is possible to create filter rules that allow users from within an organization's network to have essentially full access to the greater Internet while preventing hosts out in the Internet from having any access back into the organization's network.

Normally the firewall will allow mail and news to flow in a controlled fashion into the systems on the protected network. The firewall will also allow general requests for service (e.g., requests for a file transfer or a terminal session) flow from the systems on the protected network but not in the other direction. In this manner the firewall is almost analogous to a one-way mirror. The internal users can see out, but the external users (and hackers) cannot see in.

In addition to controlling access, the firewall can provide extra security for sensitive data. Because the firewall can identify the hosts and applications to which a packet belongs, it can provide additional security through encryption. The firewall can in essence say, "If the packet is from application X on machine A and is going to machine B, the information is sensitive and should be encrypted." The encrypted packet will be decrypted in the firewall once it reaches its destination. Using this feature, sensitive information, such as student records, financial data, or personnel data, can travel over the network and be secure even if intercepted.

Utilizing Encryption Software

The solution most often offered to insure privacy of information is encryption. Encryption involves the scrambling of data through a hardware or software embedded algorithm. The information

passes through the network in this encrypted form and is decrypted via a similar mechanism once it arrives at its designated destination.

Encryption standards have existed since the mid 1970s and are widely available and utilized throughout the data communications industry. While encryption products do offer a high level of security from data being monitored as it is transported through the network, their implementation does impact several financial, maintenance, and performance issues. Some encryption schemes can prove quite costly, especially in light of the opportunity costs involved in implementing networks in schools. For example, a school might find itself choosing between allocating budget to either a sophisticated encryption product or installing higher bandwidth connectivity or systems in the classroom. The trade-offs must be weighed seriously as both investments are extremely worthwhile.

Authentication Software

Authentication offers a unique solution to securing network resources in that it provides a highly dynamic, and therefore harder to breach, mechanism for authorizing access to networked resources. When an authentication system is employed, every instance of any attempt to access a networked resources is verified as authentic. It is necessary for every system and/or application to verify that the user or remote application is indeed who he/she/it claims to be upon each request for a service or data. This is done as a system/application generates and transmits a random challenge that the requesting system/application must properly answer.

Authentication schemes may be implemented in many different ways. This section will discuss two examples of authentication schemes, one that may be embedded in client-server applications and another which is integrated into network protocol software. The first example is Kerberos, developed by the Massachusetts Institute of Technology's Athena Project. Kerberos allows applications to share information across a networked environment ensuring that the integrity of the information is not compromised through unauthorized access. Another example, Challenge Handshake Authentication Protocol (CHAP), is embedded in a network software and ensures that only certain machines on the network are allowed to access certain other machines. When looking to purchase or otherwise obtain new applications and protocols for your network, it is advisable to inquire about whether or not an authentication scheme has been integrated into the application and, if not, what effort would be required to integrate an authentication scheme into the environment.

Kerberos

Kerberos works as systems and/or applications contact a Kerberos authentication server and exchange security information. The application/ system must successfully authenticate itself to the authentication server. This is done as a client, that wishes to request service from the server, must first request a ticket. The authentication server will then challenge the request. If the application system can provide valid authentication information, it is issued the ticket, which the client then proceeds to use to request information and services across the network. As can be seen, this system is highly dynamic in that the application server does not need to know anything about the client in advance. However, the requesting application/server cannot proceed unless it can, upon request, easily validate its presence by responding to the Kerberos authentication server challenge.

There are several advantages to the Kerberos system:

- Any application may be adapted to use Kerberos authentication;

- All the authentication information is maintained on one server, so administration is simple and straightforward, and
- Kerberos is available in source code form for free from MIT. Any application may be "Kerberized" without having to pay royalties to anyone.

Challenge Handshake Authentication Protocol (CHAP)

Challenge Handshake Authentication Protocol (CHAP) operates as the request is made for its service. The authenticating system generates a large challenge that must be operated on by the requesting system and returned to the authenticating system. The challenge in this instance is a 128-bit sequence that requesting the system must then combine mathematically with a "secret" and then send that treated challenge back to the authenticating system.

The authenticating system then performs the same process to the sequence and checks to see that the returned challenge is the same as the one it just produced. If the two sequences match, the requesting system is granted access.

There are several advantages to this system:

- The challenge response combinations are never repeated, so capturing a challenge/response pair is useless;
- The secret itself is never transmitted over the line, so it cannot be intercepted; and
- Both sides may challenge the other, so both sides can be sure of the identity of the remote system. (This is especially important when the server system wishes to transmit sensitive data and wants to be sure that it is being received by the proper systems.)

Conclusions

Security is a major concern to all professionals installing, managing, and using networks. However, only in the rarest of instances do networking dangers outweigh the benefits networking brings to business, research, and school communities. The best approach to network security is to begin with a thorough discussion of the potential risks in your specific environment, an exploration of the products and strategies available to help you avoid those risks, and concluding decisions which result in a network design that addresses the critical security needs of your network. As the network and its uses evolve, security issues will have to be revisited. However, network planners and support personnel who have developed a solid security infrastructure will be rewarded with a system that evolves with the network and serves its purposes effectively.

PART

IV

TRAINING THE STAFF

Chapter 10

Training: Who and How

Chapter 11

Training Resources

The successful use of a communications network system greatly depends on the quality of training provided for all members of the school community. Specialized support staff must be trained in system configuration, operation, and problem resolution. Teachers and administrators will need training in the use of various software systems and information resources. The chapters in this section of the *Guide* suggest approaches to providing this training and identify some of the resources available to help schools and school districts implement training programs.

10

Training: Who and How

Introduction

In order to take full advantage of the exciting resources networks have to offer, teachers and other school staff must be provided comprehensive training. The best training is pragmatic, with instruction focusing on how the technology will be used, not just the mechanics of its operation. Well-designed training supports educators in identifying ways in which technology can enhance classroom practice, improve student achievement, and contribute to teacher and student productivity.

As with Network Support (Part III, Chapter 8), training cannot be an afterthought. Rather, it must be an integral part of the network technology plan. This chapter provides an overview of the primary training components to consider when developing a training strategy. If there existed a single blueprint for such training, it would be included here as well. However, given the unique qualities of each school, such a blueprint is precluded. The key to developing an effective training program is to constantly strive to implement a flexible program that changes with the evolving needs of the learning community.

Training School Personnel

Two types of training have been identified as critical to the successful integration and use of networking technology in a school environment. These two components are interconnected, and neither can be excluded in a truly effective training strategy. These are:

- Hands-on technical training for hardware and software support staff; and
- Hands-on use training for teachers, librarians, administrators, and other school personnel, (including learning to integrate the use of the network across the curriculum).

Technical Training for Support Personnel

The first training made available should be directed to those individuals responsible for maintaining the network's technical infrastructure. Training for these individuals will need to include: management and maintenance of central office computer systems; establishment and administration of network servers; management of electronic mail accounts; investigation and resolution of technical problems; and time management and prioritization for ongoing support responsibilities. Technical support staff have the complex task of trying to stay current with the latest technological developments while simultaneously servicing the current system. Therefore, on site technical staff may wish to rely on vendors, county or district personnel, regional support staff (e.g., California Technology Project regional leaders), business partners, and outside training consultants to provide supplementary support.

Like their colleagues in technical support, individuals responsible for introducing new software tools onto the network must be well trained and afforded time to stay current with latest developments; (in some organizations these responsibilities overlap). Those who will be choosing soft-

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ware and applications for the network must understand the network's inherent capabilities, limitations, and priorities and must work closely with network support staff to ensure the integrity and security of the network.

Comprehensive training is essential for technical support personnel for several reasons. First, proper training regarding the network infrastructure will allow these staff members to make informed decisions regarding expansion and upgrading of the network. Second, only well- trained, confident staff can effectively train and support others. Third, the more thorough the staff's understanding of the tools, the more likely they are to produce thorough, customized, easy-to-use classes and documentation for other users. Finally, technical personnel assume the critical responsibility of ensuring the network's security and in this area. Thorough preparation is essential for avoiding destructive and time-consuming problems.

Training for Teachers, Librarians, Administrators, and Other School Personnel

Teachers, librarians, administrators, and other school personnel will all want to know how they can use the technology to support their particular practices and responsibilities. While a broad array of network uses may be of interest to them, these individuals are typically greatly pressed for time and will initially prefer training that directly supports their work. Nonetheless, the best Internet training is broad enough to open the minds and imaginations of the users. Training for non-technical personnel must include three critical, interconnected components:

- Mechanics (e.g., turning on the workstation, accessing email and other communication tools, using search and retrieval tools);
- Discussions of how the network can be integrated into daily activities rather than "added on" as a separate entity;
- And integration of the technology across the curriculum.

Another important aspect of training is providing an overview of the network in a broader context. Topics might include:

- Familiarizing staff with the school's overall technology plan;
- Information regarding other courses on the use of computers, including: hardware, software, and network services;
- Education on how the tools can enhance productivity;
- Guidelines for involving other faculty, parents, businesses, and the community in the network community;
- Exploring funding sources for technology projects;
- Identifying technology resources for special needs students;
- And creating an awareness of new and emerging technologies.

1) Mechanics

Anyone who has discussed technology with two people knows that no two people view technology in exactly the same way, learn at exactly the same pace, or develop their interest in technology via one linear, predictable course of events. Training staff are therefore faced with the complex task of designing and making available training that covers a core curriculum, but is flexible enough to support each individual learner. Several models exist to support such training, including, but by no means limited to: workshops which begin with standardized group instruction and then allow time for users to explore on their own, asking questions as they arise; one-on-one instruction; and small-group instruction in which individuals with like skills and/or interests are grouped together. In all of these scenarios, learners should be encouraged to rely on one another whenever possible. This will not only encourage communica-

tion and collaboration but also will help prepare staff to assist one another when technical staff are otherwise occupied.

Training in the mechanics of the network may begin with elementary computer lessons (e.g., turning on the computer, using the mouse) or, if the participants are all familiar with computers, can move directly into the introductory mechanics of the network (e.g., email, listservs). A suggested list of topics to cover in introductory, intermediate and advanced "mechanics" training sessions are listed under Suggested Training Curriculum.

Mechanics training for non-technical staff can be provided by the site's technical personnel and, when available, can be supplemented through the cooperation of vendors, district and county staff, regional support personnel, business partners, and other outside consultants.

2) Network Integration

Teachers, librarians, and others often have concerns and doubts about how the technology fits in to effective instruction. Many who want to begin using the technology have concerns about parent and board priorities and whether they will be supported in redesigning classroom activities to include the new tools.

The most effective strategy for addressing these concerns is to include in training discussions and demonstrations of the ways in which network use can enhance curriculum, support teamwork and collaboration, expand the resources available to students and teachers, and support students in becoming self-directed, lifelong learners. The best training incites teachers to think of the network as a springboard for improving existing instruction and creating new practices which better prepare students for life in the information age. In addition, effective training prepares teachers to explain the tool to parents so that they too understand the importance of its integration into all aspects of learning.

This aspect of training should complement and, if possible, be woven throughout the technical training.

3) Networks and Curriculum

The third critical component of network training is demonstration and hands-on practice, integrating the use of the network across the curriculum. As with many new tools, networks offer an opportunity for rethinking the way instruction is delivered and the benchmarks upon which student success is measured. This aspect of training must occur on an ongoing basis, increasing in depth as users become more familiar with the tool and observe which aspects of the network prove most compelling to their students. Teachers whose students are using the network discover that research and critical thinking become integral to all student projects. These teachers find themselves coaching students in methods of collecting, synthesizing, and analyzing data from a number of sources. Often initial problem solving leads to further questions. Learning to keep curriculum open to such exploration while still "covering" the material is a skill acquired with time, practice, and coaching.

Coaching in this area need not necessarily be provided by technical training staff. For example, the district's curriculum specialists might provide in-service training which gives participants the opportunity to review curriculum developed by others, discuss assessment, and practice the skills necessary for coaching and facilitating student learning in an environment in which students are researchers. Teachers who have had success developing problem-solving or project-based curriculum may be asked to share with others the processes they went through in designing these units and the ways in which the network supported student research. Technical trainers can be called in to these workshops to demonstrate new applications as necessary. (For a more in-depth discussion of integration of the

network across the curriculum see Part II, Chapter 4, Focus on the School.)

4) Placing The Network in a Broader Context

Placing the network in the broader context of school and societal reform is an important aspect of training which can be integrated across the earlier discussed trainings or provided separately. The value of this aspect of training is that it provides a rationale for the inclusion of the network across all activities in the learning community.

One of the nicest features of this aspect of training is that a large and varied number of staff can participate in its delivery. For example, administrators may speak about financing, school restructuring teams can discuss the importance of technology in the school's vision, teachers can discuss their experiences with increased productivity as a result of the network, parents and other community members can discuss ways in which networking is incorporated into their home or work lives, grant writers can share experiences they've had looking for project funding, etc.

Discussions of this nature should be ongoing. Staff meetings and other inservices are ideal forums for these dialogues, as are online conferences and bulletin boards.

Suggested Training Curriculum-Mechanics and Integration of Internet Use

Although each site's training model will vary, many schools have found similarity in the progression of topics they choose to cover in network training. Listed below are commonly shared suggestions regarding introductory, intermediate, and advanced training. The topics listed below cover the mechanics of network use only. As mentioned in several sections above, other topics should be woven throughout these trainings (e.g., network integration, networks and curriculum, and placing the network in a broader context).

Introductory Sessions

A. Introduction to electronic communications and overview of the Internet.
B. Demonstration (using LCD panel or other projection device) of electronic mail.
C. Hands on session–electronic mail (user accounts should be set up in advance so that learners can access their mail boxes, read, send, delete, and save mail, and become familiar with their email addresses).
D. Discussion of listservs and mail lists and demonstration of their use.
E. Hands on session. Learners should be guided in selecting and subscribing to listservs and mail lists, getting a feeling for the way in which they are used and the different "cultures" which accompany them.
F. Discussion of USENET News and demonstration of its use.
G. Hands-on session. Learners peruse lists and develop a feel for the way in which they are used.
H. Review of day's activities.

Intermediate Sessions

A. Review of electronic mail, listservs, mail lists and USENET News.
B. Discussion of FTP and demonstration of its use.
C. Hands on session. Learners download applications, text, and graphics; discuss various decoding schemes.
D. Discussion of Telnet (and Archie) and demonstrations of its use.
E. Hands on session. Learners use telnet (Archie) to perform database searches, access bulletin boards and multiple user devices. Provide a list of addresses for learners to practice accessing.
F. Discussion of Gopher, WWW, and WAIS and demonstration of their uses.

G. Hands on session–learners practice, using Gopher, WAIS, and WWW as productivity assistants.
H. Review of day's activities.

Advanced Sessions

Advanced learners should be guided in navigating the network in search of resources. Trainers/coaches should be available to answer questions and encourage learners to increase the depth and breadth of their searches. Learners should come to the workshops with ideas regarding integration of the Internet into the curriculum and should be assisted in developing the skills they will need to succeed in the development of this curriculum (e.g., collaboration, mentorship, assessment).

Who Should Deliver the Training

In the past, some schools have successfully integrated technology into their environment through the efforts of an individual (usually a dedicated teacher) who volunteered to be the school's technology resource person. While this may have been sufficient in an environment where technology use was not viewed as critical to an adequate education, it proves ineffective when technology becomes truly integrated into the school's identity.

Schools wishing to maximize the benefits of a network must think in terms of funding part- and full-time personnel (and/or consultants) who will be responsible for purchasing, managing, and introducing technology into classrooms and the curriculum.

There are three primary strategies for providing teacher training as listed below:

- A school staff member develops and administers a structured training curriculum,
- A training consultant provides training on an "as needed" basis;
- A district, county, and/or state develops workshops and encourages a trainer-of-trainers model.

Training Provided by School Staff

The most positive aspect of this method of training is that a member of the school staff typically has a personal knowledge of the needs and interests of his/her site and community. As the technology is introduced, the local trainer can customize the training with information known to be of interest to the trainees. In addition, as questions arise it is nice to have the trainer on site. The drawback of this method of training is that in order to be effective it will likely require more of the individual's time than most schools can afford, (remember, training includes familiarity with all resident technology, research and preparation of material, hands-on workshops, and follow-up support). Many schools combine the roles of system manager and trainer. The efficacy of this strategy depends upon the complexity of the network, its ongoing maintenance and management, support provided by the district or county, and the amount of ongoing support for staff required in order to maximize their use of the network.

Consultants

Consultants often deliver excellent training. However, the use of consultants can prove to be very expensive. Technology trainers and consultants are in great demand by the business community (networks are new to many businesses, too). As a result, well-respected, credible consultants can demand fees which are out of line with school budgets. In rural environments, consultants also include travel and lodging in their fees. Many schools find it useful to employ consultants on an as-needed basis to demonstrate new technology or to train technical staff in new applications and tools.

District, County, and State Training Models

As with network support, combining the resources of a district, county, and/or

state provides an excellent strategy for maximizing resources and minimizing costs. Trainers who travel from site to site can be employed to train on-site trainers, thereby enabling the school to have resident "experts" and be kept abreast of latest developments and technologies. In addition, this strategy supports a model in which everyone receives a core of standardized instruction followed by customized training as needed. Examples of trainers in this model are county technology specialists and regional representatives of state funded efforts such as the California Technology Project and the Telemation Project.

Delivery of the Training Program

Delivery of network instruction can take many forms. A sampling of these are listed below, however schools are strongly encouraged to be creative in combining these various forms of delivery and creating their own.

Workshops

Workshops can be an effective means for bringing learners together to share the experience of becoming familiar with a new topic. A supportive workshop environment can help new users feel more comfortable, particularly if they are able to watch more experienced users make mistakes as they navigate new aspects of the network. Workshops provide the most effective means for presenting dynamic information (e.g., information not well communicated through videos or written materials) and also offer an ideal opportunity to combine group and one-on-one instruction (e.g., a topic can be introduced, then learners can practice, receiving assistance as needed).

Printed Materials

Pamphlets, booklets, and notebooks are effective for presenting information that is more technical or intricate in nature. Printed materials provide a reference library for users and well-written documentation provides a first line of assistance to users who have forgotten protocols and/or other routine instructions. Illustrative exercises and tutorials are extremely effective for users who have inconsistent opportunities to practice using the network, or those who learn best when self-directed.

Videos

Video tapes can be used to deliver non-technical and/or highly technical information. Taping an informative lecture, for example, greatly increases the number of staff members and students who can benefit from it. Video is also an excellent vehicle for allowing teachers to learn at their convenience and at their own pace. Further, videos can provide an effective review of skills that are highly technical and easy to forget.

The Network

Finally, it is extremely important not to forget the power of using the network to continue to support and train users as they encounter obstacles and difficulties. On-line user discussions can allow teachers to ask questions and receive immediate responses once they have left the training environment and are working on their own. The complexity and frequency of issues brought up in these on-line discussions can also assist the training staff in determining the types of additional workshops and documentation needed.

When and Where to Provide Training

It is highly recommended that network training be provided after the network (hardware and software) has been installed and is functioning so that learners are able to practice what they have

learned without delay. As mentioned earlier, workshops should always be followed with ongoing support. Refresher courses and more advanced instruction should be scheduled throughout the year (and if the staff are agreeable, during the summer as well).

Most training will occur among groups (rather than one-on-one in individual classrooms). It is important to remember that when groups are brought together in a lab setting, the computers they use should, if possible, resemble the systems they will use back in their classrooms and libraries.

Following training, learners must have easy access to the technology so that they can practice enough to become productive users. This means that whenever possible teachers should have access to computers in their rooms. When such access is not available it becomes very difficult for teachers to find the time to practice, and enthusiasm wanes.

When it comes to networks, nothing has proved to inspire teachers more than having the opportunity to observe their students' engaged in research, communication, problem-solving, and exploration with others worldwide. In addition, it is often the case that at least one student in a given class will become highly proficient at using the technology. A teacher that invites such a student to coach others (including him/herself) gains a technical assistant and increases the likelihood that the network's potential can be maximized.

Training Incentives

Teachers and other school staff may not be receptive to attending technology training for a number of reasons. These range from extremely tight schedules to spending time on other projects to a general dislike and fear of the technology. One effective means of combatting reticence is to offer incentives which encourage participation. The following incentives may prove to be effective:

- Stipends for hours spent in training;
- Career ladder credit;
- Release time so training is not always after hours and on weekends;
- Summer loan computers on which teachers can practice and become proficient;
- Special offers from vendors in which teachers are offered substantial discounts after completion of an agreed upon number of training hours; and,
- Access to materials they can use immediately in the classroom to improve the learning environment.

Although some schools report the use of incentives over long periods of time, most find that as learners discover the vast resources available on the network, their enthusiasm increases and their willingness to come to training classes exceeds their desire for compensation.

11

Training Resources

Although the following list is by no means an exhaustive directory of training resources for teachers, these samples serve to demonstrate the vast array of options available to educators today. A proliferation of technical resources exists on the Internet, and new users are encouraged to make the connection and browse. The California Department of Education does not endorse any particular training organization or consultant.

Hands-On Teacher Services:

1. InterNIC–The InterNIC Seminar Series - Training for Residents of the Global Village offers seminars covering a wide range of topics from a basic introduction to the Internet to managing an information network. In addition, trainers will travel to a "host" site and tailor courses to accommodate a given organization's needs. The calendar of seminar dates is free on-line (InterNIC Information Services) by either using email or gophering to "is.internic.net." New, intermediate, and advanced users are all welcome. Registration and pricing information may be obtained by calling (800) 444-4345 or (619) 455-4600.

2. New Technologies–Beginning Internet courses and seminars may be arranged through an organization called New Technologies, Inc. Classes cover the use of Internet tools, such as email, gopher, telnet, etc. Although sponsored through the University of Maryland, trainers will also travel to other sites and design courses to fit individual requirements. For course descriptions either call New Technologies at (410) 659-0950 or send an email message to nti@clark.net. All courses require a fee.

3. Telemation Project –The California Technology Project's (CTP) Telemation Project is a new statewide program in collaboration with the CTP, the Fresno County Office of Education, and the Far West Labs, dealing with 18 regional partners. The project aims to bring telecommunications training to California educators by focusing on integrating telecommunications-based resources into site-level planning, curriculum, learning strategies, and student-centered activities. In 1994, through the innovation of telementoring, 424 teachers will receive training in a TeleLearning Mobile Unit equipped with the latest technologies. In turn, participants will share their expertise with colleagues back at their school sites. For more information about the Telemation Project, call Chris Doyle at 800 272-8743.

Online General Information:

1. FYI on Questions and Answers. Answers to Commonly Asked "New Internet Users" Questions–Here you will find the most commonly asked questions and answers of new Internet users. It is the first of two FYIs called "Questions and Answers" (see RFC 1207 below.) To access this service, ftp to "ftp.nisc.sri.com,"

request the rfc directory and enter the filename "rfc1206.txt."

2. FYI on Questions and Answers. Answers to Commonly Asked "Experienced Internet Users" Questions–As the name implies, this RFC deals with questions at a more advanced level of usage - the follow-up to rfc 1206. Access this rfc the same way as outlined above, substituting the filename "rfc1207.txt."

3. The Hitchhiker's Guide to the Internet–This RFC provides "hints allowing new network participants to understand how the direction of the Internet is set, how to acquire on-line information, and how to be a good Internet neighbor." You can access this very popular resource by entering the hostname: "ftp.nisc.sri.com," going to the RFC directory and typing in the filename: "rfc1118.txt."

4. Teacher Education Internet Server–This is an on-line service designed to explore the ways in which the Internet could benefit teacher education programs around the world. A new addition to the CoSN gopher server, it can be reached by going to Network Resources for Education. Contained in the Teacher Education Internet Server are:

- About the Teacher Education Internet Server
- STATE Information
- Teach-It Modules
- Disciplines
- Electronic Publications
- Software Archives
- Telecommunications and Networking
- Interactive Resources
- Other Internet Resources

5. Trainmat/Network Training Pack–Trainmat is an initiative of the Network Training Materials Project based at the University of Newcastle upon Tyne, UK. The materials available on the Trainmat gopher server are designed to "assist and encourage UK user-support staff to provide network training to the UK academic community. However, the materials may be used and adapted by anyone, provided the source is acknowledged and that they are not sold on or used for commercial gain." Interested teachers may access the deeply nested Trainmat by going to "trainmat.ncl.ac.uk", then to Facilities and Services, then to University Computing Services, then to Academic Services, then to University of Newcastle-Tyne Experimental Gopher.

6. Internet Tools Summary–This list of Internet tools for Network Information Retrieval (NIR) and Computer-Mediated Communications (CMC) gives a one-line description of each tool, its function, and references to documentation and demonstrations. The list may be obtained on-line by ftp-ing to "ftp.rpi.edu," then to "pub/communications/internet-tools."

Gopher Information:

1. Gopher Jewels–This is an on-line "list service for the sharing of interesting gopher finds." The contents of Gopher Jewels covers a list of subjects from Agriculture to Weather, making Internet searches a little easier. The System Administration assumes that subscribers are either gopher developers or users. It is NOT, however, to be used for technical exchanges or for the discussion of establishing, maintaining or using gophers.

2. Go-pher It: Your Passport to the Internet–This is a two and one-half week on-line gopher workshop designed to introduce the beginner to the wide world of gopher. Training includes the basics for connecting to gopher and some gopher sites, using the search tool called Veronica, setting up bookmarks and Internet retrieval tools, such as FTP, WAIS, and WWW. Interested participants sign up by sending an email message to

listserv@netcom.com." The cost is $20 per participant.

3. Navigating the Internet –Jim Gerland of State University of New York at Buffalo and Richard J. Smith from the Carnegie Library of Pittsburgh conduct a free 14-part Gopher course on-line occasionally. Email registration places the new subscriber on a national distribution list for receiving a comprehensive offering of gopher-related lessons. For more information about upcoming courses, send an email note to Jim Gerland at gerland@ubvm.cc.buffalo.edu.

Directories:

1. Internet/BITNET Network Trainers – A subscription to this mailing list will provide you with information regarding Internet training around the country. To join this on-line resource, send an email message to: listserv@ubvm.cc.buffalo.edu. The command (in the text of the message) should read: "subscribe nettrain (your first name), space. (your last name)."

2. Internet Business Journal/Directory of Trainers and Consultants–Under the Internet Business Journal, this on-line directory LISTS names and addresses of Internet training organizations. Prospective trainers must apply to Strangelove Internet Enterprises for inclusion in the directory at no cost. Free copies of the directory are available on-line. But the actual cost of training varies according to the chosen organization and the needs of the client. For more information off-line, call Lindsay Fraser-Fazakas, Training Director, (613) 565-0982.

Newsgroups and Listservs:

1. Networks and Community –This electronic communication is devoted to encouraging local resource creation and global resource sharing. On-line publications such as these take the form of regular free newsletters to a group of subscribers. Literally hundreds of such services are available covering a wide range of subjects. Some, such as the above, concentrate on federal networking policy, new services on the Internet, funding, and trends. This server can be accessed by requesting an account from "samsam@vml.yorku.ca."

2. EDUPAGE–EDUCOM, a consortium of leading colleges and universities, produces this twice-weekly summary of news items on information technology. EDUCOM is seeking to transform education through the use of information technology. Newsletters contain an assortment of a dozen or more short technology updates and trivia, ranging from IBM internal reorganizations to Superbowl emergency services. A free subscription to EDUPAGE may be obtained by sending an email message to listproc@educom.edu.

TRAINING ORGANIZATIONS

American Research Group, Inc.
117 Edinburgh South, Suite 200
P.O. Box 1039
Cary, NC 27512
(919) 380-0097
(919) 467-8797 (fax)

Center for Advanced Professional Development
1820 E. Garry Street, Suite 110
Santa Ana, CA 92705
(714) 261-0240

The George Washington University Continuing Engineering Education Program
801 22nd Street NW
Washington, D.C. 20052
(800) 424-9773
(202) 872-0645 (fax)

Institute in Computer Science University of California Extension
740 Front Street, Suite 155
Santa Cruz, CA 95060
(800) 660-8639 (inside California)
(408) 427-6600 (outside California)
(408) 427-6608 (fax)

InterNIC

Global SchoolNet Foundation (GSN)
7040 Avenida Encinas 104-281
Carlsbad, CA 92009
(619) 931-5934
(800) 444-4345

Learning Group International
6053 West Century Blvd.
P.O. Box 45028
Los Angeles, CA 90045-0028
(310) 417-8888
(310) 410-1320 (fax)

Merit Network, Inc.
2901 Hubbard Pod G
Industrial Technology Institute
Ann Arbor, MI 48105-2437
(313) 936-3000
(313) 747-3185 (fax)

New Technologies, Inc.
Training and Consulting
One East Chase Street, Suite 903
Baltimore, MD 21202
(410) 659-0959
(410) 788-5473 (fax)

International Society for Technology in Education
1787 Agate Street
Eugene, OR 97403-1923
(503) 346-2411
(503) 346-5890

Vitek Systems Education
(Network and UNIX training)
(authorized education centers for Novell and SCO)
2052 Corte Del Nogal
Carlsbad, CA 92009
(800) 366-6655, ext. 4

TECHNICAL SEMINAR SPONSORS

Data-Tech Institute
P.O. Box 2429
Clifton, N.J. 07015
(201) 478-5400
(201) 478-4418 (fax)

DB/EXPO
NDN Enterprises
444 Castro Street, Suite 1101
Mountain View, CA
(800) 2DB-EXPO
(415) 966-8440
(415) 966-8934 (fax)

Digital Consulting, Inc. (DCI)
204 Andover Street
Andover, MA 01810
(508) 470-3880
(508) 470-0526 (fax)

Interop
Interop Company
480 San Antonio Road
Mountain View, CA 94040-1219
(800) INTEROP, ext. 2502
(415) 941-3399, ext. 2502
(415) 949-1779 (fax)

The Learning Tree
Learning Group International
1805 Library Street
Reston, VA 22090-9919
(800) 843-8733
(703) 709-9019
(703) 709-6405 (fax)

UniForum
(UNIX & Open Systems)
191 South Gary Avenue
Carol Stream, IL 60188-2092
(800) 323-5155
(708) 260-9700
(708) 260-0396 (fax)

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Networking Progress Reports

MENDOCINO UNIFIED SCHOOL DISTRICT

Background

In 1992 the Mendocino Unified School District (Mendocino) began an initiative designed to bring network connectivity to their K-12 schools and the surrounding community. The following were the primary goals which motivated the initiative:

- Located in a small, isolated, rural district, Mendocino staff recognized that in this age of ever-increasing information, the Mendocino library resources were, by their very definition, destined to be limited and dated. Similarly, staff found through its research that the Internet provided the most cost effective and efficient means of providing unlimited information to learners of all ages.
- The Mendocino district is home to "Windows to the Future," an innovative, state and locally funded restructuring initiative designed to incorporate the use of technology meaningfully across an integrated core curriculum. In order to see the connections between their learning and "real-world" problems, juniors and seniors in the Windows project seek connections with working professionals and experts in various fields. The Internet dramatically expands the ability for students, who otherwise would be isolated by virtue of their remote location, to make contact with professionals not only nationally but globally as well.
- The district believes that the Internet provides an excellent vehicle for imparting to students many of the skills they will need to prosper in the information age, such as: the ability to gather, analyze, and synthesize information from a variety of resources; the ability to communicate effectively with diverse colleagues; and the ability to use technology as a tool for solving problems.
- In order to strengthen the relationship between the district and the surrounding community, the district hopes to be able to provide Internet access to individuals and businesses at a minimum charge. This access would be particularly valuable in attracting new small business to the area.

Goals/Vision

Access to the Internet is one area of development which complements and supports Mendocino's overarching goal of creating a learning community which provides opportunities for students and teachers to become lifelong learners. The district has developed a strategic restructuring plan and views the Internet as an important tool for enhancing curriculum, creating opportunities for collaborative learning, breaking down the artificial walls between schools and the broader society, and creating opportunities for teachers to participate in dialogues with peers regarding their work, curriculum, new research, etc.

The district's specific goal for the network is to create a system which will allow learners of all ages in the community to enjoy access to the node. As a first step in that direction, the coming year will be dedicated to ensuring that Mendocino staff become well trained in the use of the network and that curriculum incorporates meaningful opportunities for students to use the network in as many aspects of their learning as possible.

In September 1993 Mendocino teachers will begin work on the first steps of a two year grant from NASA Ames Research Center. The district's responsibility in this grant is to design and write replicable curriculum for NASA in the areas of Earth Systems and Computational Fluid Dynamics, which can be disseminated by NASA via the Internet. In addition, staff, with technical assistance from the Autodesk Foundation, will be writing curriculum which introduces the Internet to students of all grade levels. This curriculum will also be disseminated by NASA via the Internet.

Technical Solution

Mendocino's network solution was to become an Internet node. By establishing itself as a node, the district is able to tailor its connectivity to its unique needs and, in the long run, anticipates great benefits, including cost savings as a result of its independence. Because its location is remote (approximately 100 miles from the nearest state university), the node will eliminate the expense associated with the toll call to the local state university and CSUNet. Teachers, parents, and students will be able to access the Internet at no charge.

Currently, the district primarily owns and operates Macintosh computers, and the majority of its computer-using staff are trained in Mac applications. The node will be established with a Macintosh interface which includes point-and-click tools for FTP, telnet, Gopher, WAIS, and electr[illegible]c mail. Mendocino views this as a more user-friendly interface than that currently available with the command-driven CORE computer.

The network node currently consists of three UNIX machines donated by Silicon Graphics Incorporated (SGI). These SGI machines are housed in the Regional Occupational Program (ROP) Technology Center, which adjoins the district's one high school. There are three Macintosh labs in the high school/ROP center (a total of approximately 50 Macintosh computers), connected with AppleTalk Local Area Networks (LANs), which share access to the Internet node.

The elementary and middle schools are located adjacent to one another, two miles from the high school. The schools have two labs on a common LAN, each with 25 computers networked via AppleTalk. Approximately 50 additional Macintosh computers are distributed throughout the classrooms, each also connected to the LAN. This network of 100 computers is connected by dial-up Internet Protocol (IP) routers to the node at the high school, allowing each computer at the grammar/middle school campus seamless access to the Internet. Plans are underway to install a fiber optic cable, which will allow the two LANs to be bridged together.

Funding

The process of seeking funding for Internet access began with a meeting between the district technology mentor teacher and a representative from the Autodesk Foundation. Following that initial meeting, a task force was formed consisting of the superintendent, the district technology coordinator, the district technology mentor teacher, two staff members from the Windows to the Future program, and two members of the Autodesk Foundation staff.

The primary work in finding a funding source was done through a

collaboration between the district and the Autodesk Foundation. The search began with the exploration of grant possibilities from BARRNet (the Bay Area Regional Research Network). The task force also explored a possible collaborative with a junior college in nearby Ukiah. A third funding attempt was to form a partnership with the county library. However, none of these solutions led to successful funding, primarily because all of these organizations are "grantees" themselves. In January 1993 Andrea McCurdy, the Networking Technology Manager for the Autodesk Foundation, spearheaded what came to be a very successful partnership between NASA, the Autodesk Foundation, and Mendocino. Through this partnership NASA is providing the district the hardware required to establish an Internet node and the circuit needed to connect the district to the Internet for two years. The Autodesk Foundation is donating to the district the expertise of McCurdy, who consults with the district, provides assistance in developing short and long-term technical plans, and is also providing one-on-one training to the staff. The district is providing staff release time and district resources to ensure that the project is successfully integrated into the district's overall restructuring plans.

Initially, the 56K line and its ongoing maintenance are being donated to the district through its partnerships with the Autodesk Foundation and NASA. In the long run the district will have to address the ongoing expense of maintenance of the 56K phone line and, in addition, will have to hire a full-time systems operator. The district anticipates being able to train both staff and students in management of the network, and its goal is to hire the systems operator from one of these two populations.

Training

Extensive training in the use of the Internet has been provided to district staff by the Autodesk Foundation and the district technology mentor teacher. Workshops have been provided to cover Internet skills, and one-on-one assistance, a critical component of Internet training, was provided during a 3-week summer workshop so that teachers could achieve competency with network tools before curriculum development takes place. While awaiting the arrival of the node, NASA provided Mendocino teachers toll-free access to the Internet. Advanced network questions are answered by a representative of the Autodesk Foundation and/or network support personnel at NASA.

In June 1993, 20 teachers and administrators from the district were awarded a grant which allowed them to visit the NASA Ames Research Center and work with NASA scientists. The goal of the three-day summer visit to NASA was to begin creating the scientist/teacher partnerships necessary for development of the new curriculum. The visit to NASA also allowed an opportunity for teachers to learn about some of the latest telecommunications research and development being explored by NASA.

Support and Development of Curriculum

There has been unanimous support for the development of access to the Internet from the superintendent, school board, and a broad cross-section of teachers. A town meeting, with presentations by the superintendent, consultant David Thornburg, and McCurdy, was held to introduce the concepts of the Internet and the goals of the program to the community. The meeting was extremely well attended, and the Internet goals were very well received by both the parents and businesses in attendance. In addition, a luncheon was held, during which local business leaders had a chance to meet with the superintendent and Joe Oakey, President of the Autodesk Foundation.

This event was also a success, and a number of business leaders in the community expressed their interest in supporting the networking initiative.

Staff at all levels and administration embrace the use of technology, and specifically the use of the Internet, enthusiastically. Prior to the Internet initiative, the district had developed a K-12 technology plan based on its philosophy that technology is an invaluable tool which must be used as one component of a plan to enhance learning and teaching for all staff and students. In line with this philosophy, over 90% of the district's teachers have access to some kind of computer at home which they use to support their school work. Teachers have been very receptive to inclusion of networking, and specifically the Internet use, as part of the district's commitment to technology. Although the district sees itself as having a long way to go before technology is truly integrated across all curriculum, it has taken several successful steps toward its goal. Listed below are examples of some of the ways in which teachers are presently using technology in the classrooms:

- In 4th and 5th grades students spend 45 minutes a day in the computer lab. In the lab they learn word processing, HyperCard, and a variety of other computer applications. They are also encouraged to use the technology to help them complete their language arts assignments. It is the district's goal to find ways to integrate this time spent in the lab more closely with project-based learning in the classroom so that eventually there will be a seamless connection in the children's minds between time spent on the computers and time spent solving problems.
- In the middle school students use various technologies from video to computers to complete classroom activities and assignments.
- In the Windows to the Future project, computers, video, and related technologies are integrated into a language arts/social sciences curriculum for students in grades 9 - 12. Students and teachers in the 11th and 12th grades are encouraged to develop projects which integrate science and math into this interdisciplinary curriculum as well. A variety of advanced specialized technology courses are available for students in the high school as well.

Throughout the Windows project, the goal of integrating the technology is to provide opportunities for students to learn how to use technology as a tool for increasing their productivity and their ability to express their views both verbally and graphically. It is the goal of the project to see a majority of the student's and teacher's day spent working on interdisciplinary projects which integrate technology, academic, and vocational skills. As a part of this goal, apprenticeships will be sought for students at local technology companies. Some of these apprenticeships may be conducted via the network.

As stated earlier, the district has a number of goals and plans related specifically to the introduction of the Internet. Among these are:

- The partnership with NASA requires that teachers create curriculum for the study of computational fluid dynamics and also for the study of earth systems. Teachers will be designing projects which allow students to research these topics, using the Internet, and also to access materials, such as LANDSAT photography and image processing programs. As a part of the curriculum development, assessment of this interactive work will also be considered.
- Teachers and students will use electronic mail to communicate with scientists at NASA and at other research and business centers as a part of the learning process. Several science teachers are part of C-SCIN, a state-

wide network of science mentor teachers. They plan to use the Internet to enhance communication between teachers and also to create a clearing house of science curriculum materials at an anonymous ftp site either at Mendocino or on a NASA computer.

- Across the grade levels, Language Arts teachers will participate in email exchanges with students and teachers across the country who are studying similar literature. Students will be taught to use the Internet as a research tool and will also work on collaborative writing and literature projects.
- Mathematics teachers in the middle school are participating in a demonstration grant provided by the state. As a part of the grant, they hope to work with the Autodesk Foundation to discuss how mathematics teachers can incorporate Internet connectivity into the mathematics curriculum and discover mathematics tools on the Internet.
- The middle school has Tuesday Project Days. On these days teacher-designed projects related to various core curriculum areas are worked on by all students for a three-hour block. For example, this year, for five of the project days, 6th graders designed and created their own technology projects. The projects were displayed at a technology fair. Among the projects were: connections to the NASA Spacelink computers, using CNN guides to study the conflict in Bosnia, using Gopher to study plant growth factors, and the exploration of MicroMuse, an artificial intelligence environment at MIT. Plans continue to maximize the three hour block of time on Tuesdays for Internet use, thus giving students an extended opportunity to access the network.
- Teachers in elementary grades plan to use Internet to access curriculum materials and to communicate with other teachers and students across the globe. Elementary teachers are included in the NASA development partnership.

Technology has been integrated into the District's administration for over 10 years. The high school was one of the first schools to use computers for student records and attendance. This led to an advisorship program where each staff member advises a group of 12 students. The computerized student information system facilitates the advisorship process. The use of electronic mail between and among schools will surely improve general communication (i.e. the speed with which staff can be informed of schedule changes, etc.) and it is expected that email forums/discussions will enable the administration to elicit staff feedback on an increasing number of issues without having to call meetings.

Security

The district's approach to security is two-pronged. Its first concern is that students and teachers are versed in the proper and improper uses of the network. The second aspect of security is ensuring that the integrity of the node is not jeopardized by unauthorized remote or local users.

Initially students were not allowed access to the Internet login procedures in order to ensure that the Internet accounts provided by NASA were used only for proper educational purposes. As the node comes on line, and students and teachers receive accounts, programs will be in place to make sure only authorized users access the system.

The part-time systems operator has met with systems operators at NASA to discuss security. This contact will continue, and employees at NASA's Network Operations Center will be available to assist those operating the node if problems arise. In addition, the node itself will be in an area that is constantly monitored

and will be placed in a separate room away from other work stations.

Initially the district plans to use two software programs (COPS and CRACK), which will track password use and identify inappropriate use of the network.

As part of the curriculum for students using the Internet, basic training includes lessons on appropriate use of the network and "netiquette," with the emphasis on students and teachers understanding they are entering a professional environment and their continued use of the Internet is dependent upon responsible behavior and ethical use. As a guideline to "Netiqutte" the district uses Chapter 2 from "The Really Incomplete Guide to the Internet." That chapter is included in Appendix E, Acceptable Use Policies.

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WOODSIDE ELEMENTARY AND FLOOD SCIENCE AND TECHNOLOGY MAGNET

Background

The Woodside Elementary School in Woodside, CA (Woodside) and the Flood Science and Technology Magnet in East Palo Alto, CA (Flood) are each dedicated to integrating technology across their curriculum in order to provide students and teachers as much meaningful access as possible to the tools of the information age. Each school had developed a discrete technology strategy for its community. However, when the schools' technology coordinators Tish Krieg and Theresa Baker met, they discovered that they shared very similar goals for their students and might be able to reach some of those goals even more quickly by developing a collaborative partnership. The collaborative was named "Networking Education Today for Access to Global Education" (NET AGE).

Goals/Vision

Krieg and Baker began by meeting and discussing two specific goals. First, they wanted their students to learn to use the Internet and their teachers to develop curriculum which offered opportunities for students to solve problems using the tool. Second, they wanted to build a bridge between their economically and socially diverse students. (Students in the Woodside school are 98% Caucasian and enjoy a very high economic status; students in the Flood School are over 90% minority and are, for the most part, of low economic background.)

The overarching goal for both schools is to integrate telecommunications/Internet within all curricular areas so that the networking technology can be seamlessly integrated into all student learning. It is therefore planned that teachers at both schools would individually and collaboratively continue to create curriculum in all areas which offers opportunities for students to use the network.

The schools share the goal of publishing a scope and sequence based on the state frameworks for each curricular area that will include a section on using "Technology and Telecommunications" (much as the frameworks have "suggested filmstrips").

In addition to demonstrating the benefits of telecommunications within the curriculum, it is also a NET AGE goal to broaden the collaboration to include the local high school and other schools world-

wide (the coordinators have already contacted schools in Japan, England and elsewhere in California). NET AGE would also like to develop "models" (including handbooks and having our teachers act as on-line mentors) to help other schools integrate technology/telecommunications within their classrooms and curriculum.

Krieg and Baker approached the Koret Foundation, asking for a small amount of funds to launch this initiative. Through the Koret Foundation, the coordinators were introduced to representatives of the Autodesk Foundation. The Autodesk Foundation agreed to collaborate with the schools and together they submitted a proposal, entitled NET AGE (Networking Education Today for Access to Global Education), which included the following goals and expected outcomes:

Goal One and Its Outcomes

It is the goal of this project to use the network and the NET AGE project to begin to bridge the social and cultural gaps between the schools in order to help build understanding between the communities, provide an exciting new vehicle for student-centered, collaborative curriculum, and reduce the high dropout rate for students of the East Palo area.

NET AGE addresses this goal by creating a safe and cost effective channel for building daily communication between and among the students, teachers, and parents in these diverse communities and by designing projects which allow all members of the learning community to contribute to the project in a meaningful way. It will be the project's goal to develop a sense of camaraderie among students as one strategy for reducing the segregation which traditionally has occurred in the high schools. It is important to note that on line communications are virtually free of many of the influences which can inspire prejudice, such as the looks of the person you are speaking with, their status socially or economically, or even their physical disabilities. It is for this reason that networks provide a uniquely safe environment for building trust between students whose fears and prejudices may be their only preexisting connection to one another.

It is expected that as a result of this contact and enhanced curriculum all students in the project will have the opportunity to see possibilities for their futures which they otherwise might not have even imagined and view individuals from diverse backgrounds as peers and colleagues rather than as people to fear or resent. In addition, it is expected that the bonds of friendship and interdependence forged at the elementary school level, as well as the exposure to innovative curriculum, will increase the students' capacity to collaborate at the high school level, take advantage of the rich cultural diversity of their communities, and increase academic achievement while reducing at least one of the factors which has contributed to the 66% dropout rate for students of the East Palo Alto area.

Goal Two and Its Outcomes

It is the goal of this project to use the NET AGE project and resources to improve the academic achievement of all of the students and to provide meaningful opportunities to teach the technology skills so vital to life in the 21st century.

In June of 1991 the Department of Labor's Secretary's Commission on Achieving Necessary Skills (SCANS) released a landmark report titled "What Work Requires of School - A SCANS Report for America 2000." This report had a major impact on both educators and businesses alike; SCANS made clear the urgent news that all jobs in America are evolving to require workers to have higher skills and that those students who are deprived of learning those skills are being ensured a life of increasingly declining wages.

NET AGE addresses the competencies and skills listed in the SCANS report by creating meaningful opportunities for students and teachers to integrate information-age technologies and learning strategies into innovative curriculum.

Goal Three and Its Outcomes

It is the goal of this project to have NET AGE contribute to the development of new curriculum and approaches to instruction and, therefore, school reform by helping teachers become comfortable with the new knowledge requirements and technologies of the information age.

The NET AGE project will address this goal by providing a safe and supportive environment in which teachers can learn through private tutorials and then on an ongoing basis alongside their students. The project will also enable teachers to help one another, thereby providing a real-world model of collaboration for their students. The technological assistance for the teachers in this program ensures that they will be able to quickly and efficiently become competent and confident with the project. In addition to learning the technical skills of telecommunications, teachers will also be helped to understand the power of allowing children to teach the network skills to one another, sometimes even surpassing the teacher's own level of competency.

Reform efforts frequently call for creative new curriculum to be designed by the teacher to meet the needs of her students and community. The network will link teachers to existing forums in which educators plan curriculum, share successes and failures, share resources and assessment tools, and support one another's visions.

It is expected that the experience teachers gain in this project will provide them opportunities to further develop their ability to:

- Facilitate learning, rather than controlling its pace, allowing students to become more self-directed and independent;
- Work more collegially with one another, with parents, and with the business community; and
- Be creative in developing curriculum which is current, meaningful, and challenging to students of all abilities.

Technical Solution

The Woodside School presently has 55 Macintosh computers which are distributed to individual classrooms throughout the school. The systems are connected via an Ethernet network and share the resources of an Apple Quadra and Laser Printers. The current connection to BARRNet is established through a dial-up IP router on loan to the school from BARRNet.

The Flood School has a 12-system computer lab and 8 systems distributed in individuals classrooms. The school has 9 modems which share two outbound circuits configured through an on-site PBX. Each classroom also has a twisted-pair data port. In the 1993-94 school year, an additional 22 donated Macintosh computers and LocalTalk network will be installed at the school; 13 of these will be used to refurbish the lab, and the remaining computers will be distributed to the classrooms. Currently, the 9 modems are used to connect individual Macs to BARRNet.

Although this initial configuration proved most adequate for the email exchange between the two sites, it became apparent that a more seamless and robust connectivity solution should be established. In addition, a limited number of student accounts had been donated by BARRNet. By establishing Woodside as a node, the local systems operator would be able to grant a much larger number of accounts and manage those accounts more effectively.

Therefore, plans were made to establish the Woodside School as an

Internet node and donations solicited which will allow connection of all the systems located in the Flood school to the node at Woodside using a Cisco Systems dial-up IP router. The Woodside site will become an Internet node by converting the Operating System on the Quadra to AU/X and will be connected to the Internet via a 56K dedicated circuit to BARRNet.

Funding

Krieg and Baker have each been very successful in attracting resources to their individual sites and to the collaborative venture as well. The position of Technology Coordinator at Woodside was funded through a donation from Oracle Corporation, as were the majority of the Macintosh computers at the school. The computer lab at Flood was put together through small donations, and additional related resources are also brought in through small donations. Wiring at Flood was provided through a donation from APEX Corporation, and Hewlett-Packard and the new Macintosh computers and LocalTalk are being provided through a grant from Oracle Corporation.

The Autodesk Foundation was instrumental in negotiating a donation from BARRNet which has allowed the schools to enjoy a limited number of no-cost accounts for students and all teachers in the project. BARRNet also loaned to the project the IP router and 14.4K modem which enabled the initial connectivity.

A two-year grant from the Koret Foundation was awarded to the project. The majority of the funds in that grant pay for released time so that teachers can meet collectively on several Saturdays throughout the course of the initiative for hands-on training and the development of a collaborative curriculum.

Most recently, a donation has been obtained from Cisco Systems, including: 2 CS500 dial-up routers, which will enable the dial-up connection between the Flood LAN and the Woodside node; an IGS router, to be located at the Woodside site; and a router card, to be located at BARRNet. The schools solicited a larger than necessary router card, which they agreed to donate to BARRNet in return for waived membership and access charges for both schools. This is an excellent example of a method for leveraging one donor's grant into more broad and useful purposes.

Training and Support

The superintendents, boards, and principals at Woodside and Flood have been supportive of the networking projects. In addition, key community members have stepped forward to offer donations to the project. Neither district was able to allocate district funding to the projects, so outside funding has been key to the project's success. An additional key to the project's success has been the initiative of the two technology coordinators, a point which is important to emphasize because it demonstrates that even a large scale initiative can be brought to fruition if the staffs agree with the plan and even just one or two staff members are willing to spearhead the work.

At Woodside, Baker serves as a full-time Technology Coordinator. At Flood, Krieg serves as a full-time computer technology resource specialist. Both manage the networking initiative and deliver classroom instruction, enabling individual teachers to integrate the computer applications into their curriculum. Krieg and Baker also manage the project's fundraising, the technical development and maintenance of the network, and provide support and training for staff.

The Autodesk Foundation provides support for these coordinators and also provides assistance to the districts in developing their strategic technical plans. Andrea McCurdy, the Foundation's

telecommunications specialist has, through the Koret grant, been able to provide one-on-one training to teachers equal to the equivalent of a graduate school course in networking (approximately 16 hours per teacher).

Teachers enthusiastically embrace the concept of integrating technology across the curriculum and have, when possible, been enhancing and adapting their curriculum to include opportunities for the students to access the computers and specifically, the network. To the extent possible, each school has maximized computer usage, and each school has plans to expand its computer use in the coming years. Students seem to very much enjoy the computers, and in many instances learning to master even small skills on the computer seems to have an exponential impact on self-esteem. The students love to receive and send email and have been innovative in suggesting additional uses for the network.

The NET AGE project is being evaluated by an independent evaluator in order to determine what impact, if any, the introduction of the network has had on student achievement. That evaluation will not be available until the two-year grant with Koret has expired.

Security

NET AGE uses AT Ease to protect the hard drives and virus scanners to ensure that applications downloaded from the network do not corrupt the network. Teachers work hard to instill in students an understanding that use of the network is a privilege and to date have never had cause to revoke a student password.

See Appendix E, Acceptable Use Policies, for parent, student, and teacher contracts that NET AGE has found suit the project's needs and are required to be signed regarding ethical usage.

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DAVIS SENIOR HIGH SCHOOL

Background

Davis Senior High School (DSHS) initiated its access to telecommunications with an AppleTalk network in its computer lab connecting twenty Macintosh computers. Jan Meizel, the computer science teacher at the high school, had little background and no formal education in the field of data communications when she embarked on improving the school's networking resources. However, she was able to establish a vital relationship with a University of California Network Administrator, Joan Gargano. Gargano provided training and technical assistance to Meizel and together they began to create a vision for the school's internetworking.

Meizel, who quickly recognized the potential value of internetworking, has, over the past few years, found ways to incorporate internetworking into the curriculum, training interested teachers at the school and lobbying for network expansion in other areas of the school to facilitate further use of the resource.

Meizel, students, and other faculty continually investigate the network in order to identify resources which enhance and expand their curricula. For example, projects have been created by Kathy Juncker and Meizel to use the San Diego Supercomputer, with local Macintosh software (provided by Lawrence Livermore National Laboratory), to enhance the mathematics and computer

science curricula. Writing projects have been developed to support "Writing Across the Curriculum," and special projects have been initiated for physics students as well as ESL, foreign language, Special Day Class, and social studies.

Goals/Vision

One very interesting aspect of the Davis networking project is that for very good reasons it began without a traditional statement of purpose. Meizel was approached by Pacific Bell at a time when very few people had begun exploring the pedagogical value of networking. It was a risk on the part of Meizel to pursue this project — one that emanated from instinct, hope, and vision. The goal in this project was to discover the educational value of a tool that had been little used in schools but which clearly held great promise. As the project developed and the value of the network revealed itself, Meizel was able to experiment and identify with her colleagues ways in which the network supported and enhanced learning.

This project demonstrated one important aspect of integrating technology across the curriculum that is often overlooked: that is, that sometimes, given how new and rapidly changing much of the technology is, our efforts to develop its educational uses are pioneering efforts. Unlike many strategies and tools which are time-tested, much of technology requires that we take what we know about good education and experiment to find ways in which technology supports it.

Technical Solution

In 1990, Pacific Bell became a partner to the school, enabling Meizel and her colleagues to substantially upgrade their network. Under the auspices of a grant from Pacific Bell and with assistance from the Internet Federation, UC Davis, Apple Computer, and Kinetics Corporation, the high school was able to substantially upgrade its computer lab local area network and connect to the Internet. The computer lab now contains 20 Macintosh workstations and a Macintosh server on an AppleTalk network. This network is gatewayed to the local ethernet and the TCP/IP protocols with a FastPath. The ethernet connects an Apple server running Unix, 12 PS2 workstations and a Proteon router. The router is connected to a 56K line to a UC Davis router which provides access to the Internet.

Funding

In 1990, Pacific Bell awarded a grant to the school providing all of the equipment necessary to expand the DSHS network, connecting it to the Internet via the campus network at the UC Davis. UC Davis, a BARRNet member, then sponsored the high school as an affiliate; this sponsorship enabled DSHS to access the Internet at no cost. Costs incurred by the school included the installation fee for the 56K line and the recurring line cost of approximately $100 per month.

Initially, the school district did not fund the cost of the dedicated line for Internet connectivity. Meizel and her students raised external funds to pay for the line to UC Davis. One year of the ongoing expense was funded by a grant from Entotek, a local business. In addition, fund raising events were sponsored in the community to support ongoing costs. Beginning with the 1993-94 fiscal year, the school included the monthly line costs in its normal budgeting process.

Recognizing that technology changes rapidly, Meizel and her colleagues are continually looking for ways to upgrade their networking resources to optimize the benefits to the students. Meizel works towards timely equipment upgrades through district funding and the grant application process. From IBM, Meizel has received eight PS2s, a server, and a variety of software. Apple awarded the school a grant which provided a server and

additional computers to be used in the lab, classrooms, and the library.

Training and Support

Initially, not everyone in the school shared Meizel's enthusiasm for internetworking. A few teachers expressed interest in the resource and Meizel provided training for them, but the majority of the faculty and administration both at the school and at the district level did not take advantage of the connection (in part, because teachers did not have access to the equipment which would make it convenient to include its use in the classroom).

Based upon the high school's success with the Internet, the district is now committed to further expansion of the network. The new principal of DSHS, Howard Cohen, who initiated networking efforts at Emerson Junior High School, is a strong supporter of networking and supports Meizel in her ongoing efforts to expand the resource and the training available to teachers within the district.

In addition, Gargano heads a consortium which has organized local institutions of higher education, as well as K-12 schools, into a cooperating unit which encourages and assists more K-12 participation in cross-grade, interdisciplinary projects. She has provided the expertise necessary to encourage the district to begin work on a districtwide network as well as plans for districtwide access to the Internet backbone. Meizel is participating in the design of the Davis districtwide plan and serves on the Yolo County Office of Education's Telecommunications Task Force. She is also working to encourage federal support of K-12 internetworking as a board member of the Consortium for School Networking. This visibility prompts others in the district to think about the use of data communications and to call upon Meizel to help them with local area network design.

DSHS Internet connectivity is an excellent example of an initiative spearheaded by one teacher which has resulted in a districtwide commitment to data communications.

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EL DORADO HIGH SCHOOL

Background

El Dorado County's growth rate is one of the highest in California; the resulting increase in the student population has severely strained school resources. El Dorado High School (El Dorado) serves 1,800 students on a campus built for 1,200. Although portable classrooms have been added, core facilities such as the library are unchanged and are woefully undersized.

In reviewing their predicament, librarian Kate Doyle and several of her colleagues recognized that access to electronic resources would serve the school in several important ways. First, network access would exponentially increase the resources available to students and staff without requiring more space. Second, the network would provide a cost-effective means of helping the school overcome many of the barriers it faces as a result of its geographic isolation Finally, the network was perceived to be a tool which would support the staff in its efforts to inspire academic excellence for all students.

Prior to the initiation of the network project, El Dorado had one computer in the library office which was connected to a modem and a phone line. Doyle and a

few teachers had email accounts on CSUNet through the CORE application and were thereby able to access some Internet resources, but many of the teachers experienced dissatisfaction with the limitations of CORE and the dial-up method of connectivity.

Goals/Vision

As one component of its improvement efforts, El Dorado initiated a self-review process involving students, parents, school staff, and community members. As a result of this self-examination, the school identified a shared core belief that students need to be better prepared for a global, dynamic, and information-intensive society. In a separate but related districtwide effort, teachers emphasized more student-centered learning as part of its restructuring goals. Teachers agreed that by capitalizing on students' talents and interests, they would be better able to motivate them academically.

The Internet was agreed to be an ideal resource for assisting the school in addressing all three of these vital issues. It provided a cost-effective means of introducing the students to people and resources worldwide, would be able to support the interests and talents of the widest spectrum of student interests, and, by virtue of its interactive nature, provides an excellent means for helping teachers design curriculum which requires student empowerment.

In addition, Doyle began to advocate for using the Internet as a vehicle for collaborative projects both within and beyond the school. She proposed, for example, that science classes could work with classes from other schools in shared data collection and analysis; literature and English classes could join writing collaboratives; and students and staff could participate in global discussions on almost any topic.

Finally, teachers would be offered the opportunity to join dialogues and conferences and enroll in distance education courses.

Technical Solution

In 1993, El Dorado purchased 25 Macintosh computers and networked these using AppleShare. These stations were set up in a lab, were networked to the library, and were designed to serve as resources to students doing writing and research. The school's goal was to connect this network of computers to the Internet, offering individual email accounts to interested students and staff. In April, the school's Library Media Center installed a UNIX server with a dial-up PPP connection to the Internet through BARRNet (Bay Area Regional Research Network), bringing their goal to fruition.

Funding

In order to accomplish their connectivity goals, El Dorado needed to acquire the following: Gatorbox ($1,700); router ($1,800); UNIX server ($3,000); installation of two phone lines ($142 to Pac Bell and $200 to a contractor to bring the lines to the appropriate inside locations); and BARRNet membership ($1,200 for 12 months). El Dorado additionally anticipated costs of approximately $110 per month for the digital lines.

As a result of a proposal written to BARRNet by the school, BARRNet agreed to provide a UNIX server to El Dorado as a "long-term loan." Brian Lloyd, a BARRNet consultant, personally loaned a Telebit NetBlazer to the school to serve as the router. To finance additional costs of the network, Doyle used $3,300 from the school's federal Chapter 2 funds to pay for the Gatorbox, BARRNet membership, and phone lines (these funds had already been committed for library expenses). In addition, Lloyd donated his time, providing invaluable technical expertise which facilitated the establishment of a technically sound connection.

Training and Support

Doyle has spearheaded the training effort at the school and issues students and faculty email accounts only after they have received her training in Internet procedures, "netiquette," and how to find resources on the net. Given the nature of the tool, Doyle and the school recognize that training will need to be provided on an ongoing basis.

Introductory sessions for staff have been organized by content area, highlighting resources of value for that subject area. Doyle also identifies teachers interested in collaborative projects and provides specialized training for them in order to support their collaborations. Written "cheat sheets" for applications and topic pathfinders provide point-of-use assistance. After-school sessions provide students the opportunity to learn about specific applications and sources of information. In addition, student assistants are assigned specific subject areas in which they are asked to become "experts."

In keeping with the school's overall teaching and learning philosophies, the majority of ongoing Internet training for students is integrated with content instruction through resource-based assignments and projects.

El Dorado envisions itself being able to provide training and demonstrations to other high schools and elementary schools in the district and will engage students as trainers whenever possible.

Evaluation

El Dorado is collecting information quarterly regarding:

- The number of students and staff who participate in training;
- The number of students and staff with active accounts;
- The amount of network traffic originating from the site;
- The number of messages received;
- The names of telnet sources used and frequency of use;
- A description of collaborative projects including subject area and number of students involved;
- Number of new resources used by individual teachers to supplement classroom instruction; and
- Number of students who cite online information sources in reports.

In addition, narrative descriptions of projects and uses of the network will be collected from participating teachers. A random sample of students who have email accounts will be surveyed regarding specific use patterns and student perceptions of the benefits and drawbacks of computer-mediated communication. Evaluation data will also be examined for gender differences; one hypothesis that will be tested is that computer-mediated communication and real-world experiences in science foster increased success and improved attitudes for young women in the areas of physical and computer sciences.

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LOS ANGELES COUNTY OFFICE OF EDUCATION

Background

The Los Angeles County Office of Education (LACOE) supports eighty-two K–12 school districts in Los Angeles County. LACOE's support system is hierarchical in nature, with individual school districts supporting the 1,660 schools within the county. This hierarchical model works well for LACOE. The

number of districts and schools within their county make it impossible to provide adequate support in any other manner.

Goals/Vision

Three years ago, LACOE developed its mission statement and identified four strategic goals. The mission and goals are as follows:

Mission Statement: We are a leading regional educational agency providing leadership, programs, and services to prepare an educated citizenry for the 21st century.

Strategic Goal 1: We will identify, develop, provide, and disseminate exemplary specialized programs for at- risk and other targeted populations.

Strategic Goal 2: We will be a model and primary provider of organizational and staff development services.

Strategic Goal 3: We will develop and implement an integrated communications network for service delivery and to assist in decision-making, policy development, and constituency building.

Strategic Goal 4: LACOE will use technologies (voice, data, image) to develop and deliver educational information, curriculum and instruction, and staff development to every classroom in the region.

Goals 3 and 4 clearly set the stage for the future direction of LACOE's technology team. However, it was recognized that in order to begin providing the kinds of services they wanted to provide to every classroom in their county, a sophisticated communications infrastructure would first need to be established.

In supporting its own administration, LACOE is planning to use the Internet to communicate with its schools districts, county offices, and others worldwide, using email and FTP. (The county offices in the ten southern counties of California have all pledged to be connected to the Internet by the end of Summer 1993.)

The office is currently in the process of training its curriculum staff so that they will be able to develop strategies that integrate the Internet across the curriculum. These curriculum specialists will then be responsible for supporting the individual schools in bringing their staffs on board with the network.

LACOE has only recently offered FTP capabilities on the Internet; but word has traveled fast, and the demand for connectivity to both the Internet and the county office is keeping LACOE staff extremely busy. One unified school district is connected to the Internet through LACOE and a second district will soon be connected. Several other districts have expressed strong interest in this service and discussions with that district are underway.

By the end of fiscal year 93/94, LACOE estimates that eight to twelve districts will be connected via a digital line to LACOE. The county office will continue to assist school districts in their connectivity plans and expects the number of districts wanting a digital or Internet connection to climb.

LACOE's future plans include providing news services, bulletin boards systems, and Gopher servers via the Internet to county office and district staff, writing new interfaces to their mainframe applications, and providing district-to-district connectivity.

Technical Solution

Three years ago all the districts within LACOE's domain connected to the LACOE BULL mainframe via analog lines. Today, the analog network that connects to the mainframe is being re-

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placed by a digital T-1 network. As district funding permits, several districts are replacing their analog lines with digital lines, thereby increasing the speed of their data transmissions. In some cases, the districts are merely switching from analog to digital by replacing their modem with a DSU/CSU. This allows them to move up in speed from 4.8K to 19.2K. Other districts have switched to a LAN/WAN based connection, using a router and a 56K ADN line to connect to the T-1 network.

The use of the mainframe is still a very important part of LACOE plans. They have recently installed a TCP/IP gateway so that microcomputers on a LAN can access the mainframe applications through a terminal emulator. All communication is via TCP/IP. LACOE is planning the installation of a UNIX front-end communication processor to the mainframe, which will enable the mainframe to look like a UNIX server for the purposes of doing uploads and downloads using FTP.

The office is running AppleTalk LANs with AppleShare Servers, IPX LANs with Novell 3.11 as the server and are running an Ethernet backbone. The LACOE LAN is router-based.

Funding

The connection to the Internet was initially funded by several divisions within LACOE that had a requirement to send electronic mail to other Internet users across the country. These divisions shared the cost of the installation. Now LACOE operates much like a mini-Internet Service Provider (ISP). For a flat annual access fee (and the cost of the routers), districts within Los Angeles County can route to the Internet via LACOE's server. The flat fee includes technical support and places LACOE and the district in a win-win situation (LACOE charges roughly half what other ISPs charge).

Training and Support

LACOE has established a help desk to receive incoming calls from its constituent districts on technical support issues, networking, software questions, and hardware acquisition. The majority of calls can be handled over the telephone, but occasionally LACOE staff make site visits to address a particularly problematic issue.

The training program at LACOE is a cost-recovery operation. Technology training (including Internet usage training) is offered by the Network and Information Services (NIS) Division within LACOE and is available to county and district staff. NIS announces class offerings by publishing available courses and their costs. Classes are taught at LACOE, although LACOE staff are willing to provide on-site training to districts who have the facilities, equipment, and networked environment for training.

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MONTA VISTA HIGH SCHOOL

Background:

Monta Vista High School is in the Fremont Union School District and is located in Cupertino. The student body consists of about 1,650 students, largely from upper-middle-class homes. The majority of students are college-oriented. The following numbers categorize the ethnic diversity of students at Monta Vista: 40% Asian, 5% other minority, 55% Caucasian.

Monta Vista has been part of the California Model Technology in the Schools Project. As a result, the school owned over 100 networked Macintoshes prior to its foray into internetworking. The majority of these computers were distributed throughout three labs. The teaching staff was knowledgeable in general computer use (word processing, etc.) and often made use of the technology in the classroom. Other enhancements, such as computer screen projection, further facilitated computer use.

The computers within the labs were networked with LocalTalk hardware. This system was used to allow lab computers to access data and software from the file servers. In addition, printer sharing was enabled via a network.

The impetus for the Internet project at Monta Vista was externally driven by NASA Ames Research Center. As part of the High Performance Computer and Communications Act of 1991(HPCC), federal agencies were tasked with helping K-12 schools utilize Internet technology. In early 1992 NASA networking technologists chose Monta Vista as a partner to begin testing (in a hands-on fashion) the impact of Internet within a high school.

Goals/Vision

The following were the project goals agreed upon by NASA and Monta Vista:

1) to utilize Internet in student projects that involve research in the areas of aeronautics and space for physics and general science courses;
2) to explore the Internet to discover how it can be valuable in other educational settings;
3) to create guidelines/instructions for the responsible use of Internet that can be effectively used by other students and schools;
4) to begin creating a database of the resources found on the Internet that are useful to high school students and teachers;
5) to establish formal contact with other schools and assist them in using Internet;
6) to participate in group research projects that involve students from other schools and science mentors (from NASA or private industry); and
7) to exhibit ethical use of the network .

Technical Solution

Monta Vista was connected to the Internet by BARRNet, a third party service provider with a strong presence in Northern California. A leased 56K circuit and dedicated hardware (IP router and CSU/DSU) were installed; this provided an Ethernet interface to the Internet. Additional hardware, including a 4-port transceiver and Comtalk router, were used to enable connectivity between the existing AppleTalk system and the outside world. Also, an older Sun 3/60 was provided as a home for electronic mail. The system was designed to integrate with the existing network and to augment, not replace, previous capabilities. Specifically, it was designed to allow Internet access directly from individual Macintosh computers.

A major benefit of this network connection was that it provided easy-to-use Macintosh applications, such as TurboGopher, Fetch, Eudora and WAIStation.

The point-and-click nature of these applications made it easier for teachers and students to navigate the Internet. In addition, the connection allowed many users to access the network simultaneously and made possible group training. Another benefit of the design is that the dedicated circuit provides much better performance than a modem/phone line solution. This allows for faster file transfers and facilitates more rapid browsing of potential Internet resources.

The biggest disadvantage of the approach revolved around the Unix workstation. Support of the system has been a continuous problem for the school. NASA was not prepared organizationally to maintain the system, and Monta Vista was not prepared technically for the role. Administration of a Unix computer is a very complex task and requires significant people resources. The experience at Monta Vista strongly suggests that the necessary human and technical resources for maintaining a Unix workstation must be identified at the start of the project if one is to be involved. Similarly, the SUN computer was an older model which had inadequate disk space and was originally configured with an incomplete operating system. Once again, it was demonstrated that integrating older donated hardware into the school's network without adequate support is an approach which can create more problems than it solves.

Funding

The communications hardware and ongoing circuit costs for the first three years of operation have been funded by NASA. After the initial three years, the school will be expected to fund the ongoing costs (approximately $2,000/year).

Training and Support

During the first year of the project, participation was limited to only a few teachers and approximately 15 students. Because NASA expressed a concern about ethical use of the network and security issues, students applied to participate and were selected through a screening process (see attachment below).

Some hands-on training was provided by NASA to an original group of participants. Over time, the teacher liaison and other student "experts" taught classes to the additional people who joined the project. These tutorials were held outside of regular school hours, without compensation.

Because the students often couldn't meet at same time, the same tutorial was usually given twice (once after school, and once on a Saturday). NASA continued to provide a last line of support for questions which arose and could not be resolved within the school, however, the response time to questions from NASA was often slow. This time lag between questions and answers was very frustrating for the teachers and students. The experience points out the importance of having local (within the school) experts who are able to quickly resolve technical difficulties.

The Internet project at Monta Vista began as a pilot effort. Other than a few lead teachers, no effort was made to provide training or awareness for the entire teaching staff. As a result, all student involvement took part outside of the normal curriculum.

Evaluation

A formal evaluation process has not been employed for this project. Although students did fill out an initial questionnaire, and a post questionnaire has been developed, the turnover in the group and lack of time and interest made evaluation a low priority. Instead, NASA and teachers have relied on direct feedback from students and individual observations to assess whether project goals are being met.

The following are observations the teachers have recorded regarding the implementation of the project to date:

1) Providing hardware is only a start; ongoing, timely technical support is vital to project success.
2) The Internet, as it was accessed in this connectivity solution (UNIX-driven), was not very user-friendly. Applications such as TurboGopher, Mosaic, and Eudora significantly improved our access, and we feel applications like these must continue to be enhanced and made widely available. Our original problem was that more time was spent teaching users to navigate the Internet through the UNIX interface than in learning what educational resources were available.
3) A substantial investment in time must be made to train teachers in the use of Internet (beyond email). Only when teachers are comfortable with the resource (at least understanding what it can do) will they encourage students to access the network for resources, or create specific student projects integrating its use.
4) Focusing on math/science applications can be a mistake. The Internet is a tool that should be utilized across the curriculum. The goal at the K-12 level should be to get students to learn the tool in its broadest utilization.
5) To be successful, the use of Internet must be integrated into the curriculum rather than just being a "club" or volunteer activity.
6) Finally, frustration with hardware problems or navigation of the Internet can kill student and teacher interest. There must be ongoing site support for all aspects of Internet use.

Plans call for focusing more on the teaching staff. Two teachers knowledgeable in the Internet are spending paid time during the Summer of 1993 to further investigate the Internet. Their goal is to identify good resources which will be useful for other Monta Vista teachers and to create model lesson plans across curriculum areas.

The broad goal for the 1993-94 school year is to begin using the Internet as a tool for day-to-day classroom activities.

The following was provided to students wishing to participate in the NASA/Monta Vista High School Internet Project:

In an effort to educate students about "long-distance" learning and the importance of telecommunications and networks, the National Aeronautics and Space Administration has approached two high schools to be involved in a project involving access to the Internet. NASA at Ames in Mt. View has identified Monta Vista as the West Coast site.

The following are the project goals that have been agreed upon by NASA and Monta Vista:

1) to utilize Internet in student projects that involve research in the areas of aeronautics and space for physics and general science courses;
2) to explore the Internet to discover how it can be valuable in other educational settings;
3) to create guidelines/instructions for the responsible use of Internet that can be effectively used by other students and schools;
4) to begin creating a database of the resources found on the Internet that are useful to high school students and teachers;
5) to establish formal contact with other schools and assist them in using Internet;
6) to participate in group research projects that involve students from other schools and science mentors (from NASA or private industry); and
7) to exhibit ethical use of the network .

The last goal is an important one. NASA is sponsoring (and therefore is responsible for) communication between the school and universities, libraries, research institutes, major businesses, and government agencies all over the world. They are very concerned that Monta Vista

students learn and practice responsible and ethical utilization of Internet.

Students who are accepted into the project have a direct obligation to adhere to the standards expected by NASA. Any irresponsible conduct could lead to a termination of the project and cause a great loss to the other Monta Vista students and teachers involved.

A core of 6 to 12 students will be identified to participate in the project. All students who participate in the project will be expected to work toward fulfilling goals 1 and 7 and may address other goals that interest them. Internet students will be required to keep a personal log, and occasionally students may need to attend a lunch meeting to receive information or directions concerning Internet use. Variable credit/Independent Study will be available.

If you wish to join the Internet Project you need to complete the following:

1) a computer lab agreement form
2) a NASA/Internet agreement form
3) an Internet Project application

In addition, those students selected will need to attend a presentation on network security and ethics by a NASA liaison.

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SAN DIEGO COUNTY OFFICE OF EDUCATION

Background:

The San Diego County Office of Education (SDCOE) provides support to 43 school districts and several schools in the area of information technology. While SDCOE encourages schools to obtain support services from their district, occasionally SDCOE will assist individual schools in their technology efforts.

Goals/Vision

In the Fall of 1992, the County Office of Education's Information Management Services unit authored a comprehensive needs assessment and strategic plan based on 80 personal interviews with county and district staff. The purpose of the study was to identify client needs, prioritize those needs, identify and acquire the necessary resources to meet those needs, and develop an implementation strategy in a fiscally sound and responsive manner.

Two prevailing comments during the interviews were that "technology should not be a separate framework" and that "technology must be part of the process." In an effort to bring technology into the classrooms in San Diego county, SDCOE began its venture into internetworking.

SDCOE's involvement in computer internetworking stems from the initiatives of the "Three Southern Regions Consortium," which, in trying to save resources, set four principle goals:

1) to establish a communications network among the counties in southern California;
2) share contracts;
3) establish a common computing architecture; and
4) standardize data.

In meeting the goal of establishing a communications network, Los Angeles County Office of Education (LACOE) and California State University Network (CSUNet) were available to help SDCOE. LACOE offered their technical assistance and CSUNet offered connectivity to the Internet.

Integrating instruction/classroom/administration capabilities is at the heart

of SDCOE's goals. The office envisions itself serving as a technical hub for districts that wish to connect to the Internet and will provide the expertise to access and use the Internet successfully. For those who already have a history of using the Internet, SDCOE is prepared to offer help where needed but will not get in the way. They hope to build on the success story of a few districts to help apply momentum to the concept so that eventually all districts will be able to use the Internet effectively. The concept has been embraced by the California State Curriculum and Instruction Steering Committee and the State Business Administration Steering Committee.

Technical Solution

There are currently four networks in place at the County Office. SDCOE runs both Novell and AppleTalk networks. They are presently not interconnected but will be in the near future as SDCOE's internal wide area network is currently being implemented.

All districts are connected to the SDCOE Unisys mainframe through a combination of lease lines and dial-up using terminal emulation software. It is the SDCOE's goal to establish LAN connections to all district offices within the county.

SDCOE connects to CSUNet through CSU at San Diego via a 56K line. This CSUNet solution met SDCOE's needs and a similar implementation was in use at the Los Angeles County Office.

The benefits of this connection are that it supports both business and instructional needs, is in place already, and is time-proven. The disadvantages are that it is somewhat difficult for the infrequent user to use without assistance (to that end a help desk capability is being implemented) and its telephone line-based topology does not readily offer some of the potential offered by some of the higher bandwidth-based topologies, such as fiber, microwave, etc.

Funding

CSUNet allowed SDCOE to become functional without a large financial expenditure. No grants were sought because the length of time to acquire one would have severely hampered SDCOE's ability to become functional by the summer of 1993 (their driving objective). Therefore, all funds for San Diego's networking were allocated from existing budgets.

Training and Support:

SDCOE has implemented a help desk that handles technology support and training and will be a combination of internal SDCOE networking personnel and college student workers from the San Diego area. They have had marked success in using student workers to augment their work requirements and will continue to use that capability. SDCOE's concept is to have expert personnel available at all times via telephone who can help users access the system and can also help them navigate the Internet.

SDCOE plans on expanding their very proactive help-desk services. They see this as being a major step in removing the "difficult to use" criticism of CSUNet/Internet. After gaining some experience/expertise in supporting CSUNet and the Internet, they will find ways to blend some of the other capabilities of other networks into their scenario. SDCOE is already working with UC San Diego toward that objective.

In addition, SDCOE's Technology Consortium provides a wide variety of education technology workshops, academies, services, and activities to pre K-12 educators and others throughout the San Diego and Imperial Counties. Included in their offerings this fall is an Internet class.

SDCOE also has acquired and equipped two vans with computer laboratories. Both labs were outfitted with eight

workstations, each for less than $1,000. These vans are literally mobile training facilities and are maintained and staffed by college students. Initially, staff development courses were offered through the traveling labs. The labs have since expanded their offerings to include technology training.

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SAN FRANCISCO UNIFIED SCHOOL DISTRICT

Background:

"Access" is San Francisco Unified School District's (SFUSD) operative word in dealing with technology implementation. In a metropolitan area with a 65,000 student population, SFUSD wanted to "increase student learning and achieve academic excellence," as well as provide an efficient administrative tool for the district's staff through the use of state-of-the-art technology. "Where people have access to appropriate tools, they can learn and work efficiently, making the best use of time, energy, resources, and money" (SFUSD's Technology Plan, p. 4).

In 1981, Superintendent Alioto established a task force to develop a computer master plan covering the instructional and office uses of computers and the necessary training. Due to budgetary constraints, the district did not start a technology pilot until 1983; the pilot targeted six schools. In 1987 the new superintendent, Ramon Cortines, revised the master plan, focusing on the need to better integrate computers into the curriculum. In 1992 SFUSD's current superintendent, Waldemar Rojas, raised the need for a formalized strategic plan for the district which builds upon the district's previous computer master plan. From the new strategic plan came the Technology Master Plan 1993, which "makes recommendations pertaining to the use of all forms of technology for instruction and management districtwide" (p. iii).

Technical Solution

Currently, the existing centralized mainframe environment prohibits the district from pursuing its goal of expansion to reach all students and personnel within SFUSD. Thus, SFUSD is turning to a decentralized networking environment as a cost-effective solution.

The 1993 Technology Master Plan outlines an automated networking environment, eventually phasing out the existing mainframe within the next three years. In general, the decentralized, networking environment establishes local area networks in each school site which connect to the district office, using 56K lines and/or ISDN lines. The district office connects to the Bay Area Regional Research Network (BARRNet), using a T-1 connection, enabling access to the Internet. This network configuration allows connectivity to every school. In addition, it enables SFUSD to access the diverse services the Internet provides.

Funding

The estimated cost for full implementation of the district's entire technology

plan is $66 million dollars over a five-year period. SFUSD plans to rechannel funds from other sources to support implementation of the plan. In addition, a county sales tax passed on June 16, 1993 allocated a quarter cent of every dollar to go to San Francisco schools; these additional funds will in part be used to fund the master plan. The district will seek other funding efforts in the future as needed.

Training and Support

In recognition of the dramatic ongoing changes in the technology arena, the district is committed to retraining existing staff so that they will be prepared to support the new decentralized project. Although staff attend formal classes, most of the training is conducted through on-site and "learn-as-you-go" situations. A central help desk located in the district office is available for technical assistance. It is SFUSD's goal to encourage each school site to develop its own technical support person or group.

Within the next 12 months (by July 1994), 39 key sites (elementary schools) will be connected to the district office. Other schools will be included when they are ready, based on their financial and technological status. SFUSD is planning to completely switch from mainframe to client/server wide area network in three years.

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SAN JUAN UNIFIED SCHOOL DISTRICT

Background

Four years ago San Juan Unified School District (SJUSD) owned a Sperry 1170 mainframe, 20 lease lines with multiplexers, 60 personal computers, and no network. The school district utilized the computer technology for administrative applications only. As the State reporting requirements changed, the existing batched environment could not feasibly accommodate the new requirements. Therefore, the district turned to on-line networking solutions for student administration.

Technical Solution

Today, SJUSD has over three years of experience in managing a districtwide internetwork based upon TCP/IP. Initially, the Information Systems (IS) staff chose a bridged network design with 10BaseT as the local area network wiring, standard, and leased 56K ADN lines, with remote bridges for wide area network connections. While this design served the district well and provided the most cost-effective solution at the time, it quickly reached its expansion limits.

The SJUSD IS staff is currently beginning a phased reconfiguration of their network, moving to the use of routers for flexibility and increased control and management of the network. All active devices on the network will have Simple Network Management Protocol (SNMP) capabilities to permit centralized monitoring from a Unix workstation in the district office. The SJUSD staff no longer recommends a bridged network for a districtwide design. Instead, they highly endorse the use of routers throughout the district for any school district just beginning the network design process.

Currently, two networked instructional pilot sites from the district connect to the Internet through BARRNet. Through this connection, teachers and

librarians use Internet resources, especially electronic mail. In addition to a centralized server primarily providing district mail service, SJUSD IS staff are also testing Internet client/server mail applications (Eudora for the Macintosh and Acorn for the MS-DOS computers) and information retrieval applications (Gopher) to optimize their use of the distributed computing environment.

Training and Support

Management and support of the districtwide network is a growing concern for IS staff due to the increase in academic use in addition to its original administrative functions. The current level of technical support staffing is based upon support of administrative systems on networks designed, installed, and maintained by nine IS staff. Since academic networks may be more dynamic and easily modified by school faculty to meet changing classroom needs, SJUSD is planning to use the features of routed networks to separate the academic from administrative network. In addition, SJUSD staff are researching the successful distributed support methods implemented by local colleges and universities to assist them (the school district) with their own support planning for the growing user population.

One of the key elements in the efficient implementation of technology in SJUSD rests on the district staff. Operating without a formal technology plan, the group undertook a project estimated (by outside consultants) to start implementation within seven to nine years and fulfilled it in two years. Speedy, "crunch-mode network planning" allowed the school district to take advantage of current available technology flexible enough for expansion and improvement, proceeding with the rapid implementation.

By the end of 1993, SJUSD plans to install the local area networks, which will be used primarily for instructional purposes, on 10 selected school sites. The subsequent phases include the connection of over 70 school sites in district, serving its 48,300 student population.

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SAN DIEGO CITY UNIFIED SCHOOL DISTRICT

Background

San Diego City Unified School District (SDCUSD) includes 155 schools with approximately 124,000 students enrolled. It is estimated that by the year 2010 enrollment will reach 150,000 students.

With such a dramatic growth rate, overcrowding in the districts schools will continue to be an issue of concern. To alleviate some of the problems which accompany a rapid growth rate, the San Diego City Schools Board of Education has successfully passed a $245 million bond (Proposition O), which will be allocated primarily for the building of 4 new schools, building additions to 6 existing schools, as well as the renovation and modernization of 27. Of the 245 million, 24.7 million will be placed toward the development and implementation of educational technology.

Goals/Vision

In an effort to integrate technology into every classroom, and enhance teaching, learning, and management, the Board of Education adopted the following policy:

"The Board of Education recognizes the evolving impact of technology on schools and supports the use of technology

to improve instruction and increase accountability for decision making and student progress."

To proceed with this policy, former Superintendent Thomas Payzant established a Technology Study Team composed of site staff, central office staff, and parents. With the assistance of an IBM consultant to facilitate the planning process, the team completed a five-year technology implementation plan which lays out the district's technology needs for the period of 1992–1997.

SDCUSD's involvement with the Internet is just beginning and the district is part of a testbed funded by a National Science Foundation grant received by Bolt Beranek and Newman Inc. (BBN). The testbed will last for a period of 18 months and will hopefully pave the way for broad-based access to, acceptance of, and financial support of school networking.

Technical Solution

In an effort to cut costs and streamline the structure and efficiency of the district's Information Service Bureau, four administration centers dispersed throughout the city are being consolidated into two administration centers. A 56K line from the district's central office to CERFnet will provide direct access into the Internet. Plans and implementation for connecting to the Internet were provided by BBN.

In order to address internetworking within the district, as well as to external resources, the District's Information Service Bureau is in the process of changing its existing SNA system to a TCP/IP system. Plans are to set up a district network so that distributed networking can take place.

So far, eleven schools are in the process of receiving connections to the Internet. Schools currently having dial-up accounts are:

- Scripps Ranch (T-1 connection to the central office will be established 9/93)
- Bell Junior High
- Morse High School
- San Diego High School
- Farb Middle School
- Gompers Secondary School (grades 7–12)
- Serra High School
- Point Loma High School

Future plans involve each department in a school to be connected via Ethernet to the school's LAN. Each school's LAN will be hooked up to a router which will provide connection to other schools in the district, as well as the central office. It is a goal of the SDCUSD to provide every classroom a computer connected to the school's LAN. The library will be set up with approximately 12 computers.

Funding

Seeking out funding for the SDCUSD is an ongoing task. Members of the Technical Study Team work with financial decision makers, including: the superintendent, the assistant superintendent, the budget department, and the San Diego business and residential communities.

SDCUSD has found that its community has made a vital difference in its financial support. In 1974 a taxing authority (Proposition XX) approved by the voters gave the district an opportunity to use existing taxing capacity until the year 2003. Prop. XX stipulated that only a simple majority of the voters would be needed to grant the use of funds gained from the taxing authority.

In 1988 the voters passed proposition Y, which granted $147 million of the taxing capacity to build 9 new schools, remodel and expand 8 existing schools, and build science laboratories at 9 senior high schools. The building program, made possible by proposition Y, is proceeding on time and within budget.

Training and Support

Although the total infrastructure for the district's TCP/IP network is not in place, it is anticipated that in the future other schools besides Scripps Ranch will have internetwork capabilities. In the meantime, by not having the TCP/IP network in operation at other schools, training SDCUSD representatives is temporarily a problem. In an attempt to begin internetwork training, the district main office may decide to open the administration center to schools. Other training facilities will be strategically located at school sites throughout the district.

Teachers accessing the Internet via a dial-up account are very pleased with the Internet's resources. It is anticipated that a 56K line into the central office will be an added benefit when accessing the Internet. This type of connection will further enlighten teachers and will foster effective and creative use of the Internet's resources.

Some teachers, involved in the Teachers Education Program, have received Internet training at the University of California, San Diego. It is anticipated that they will become mentor teachers for the district.

Network support for the district will be centralized at the Information Service Bureau and its current help disk will be extended to serve the needs of the district.

Evaluation

Evaluation of the TCP/IP is currently being implemented by tracking electronic mail usage. BBN is the organization monitoring utilization. Because the TCP/IP network is in its infancy, other methods of evaluating the network's infrastructure and use will need to be developed.

A Problem to Consider

At the time the district opened its TCP/IP network to the "outside world," communicating to other networks on the Internet was not possible. Because San Diego did not follow the Internet Engineering Task Force's (IETF) Internet Protocol naming conventions, they encountered a number of problems. These problems eventually forced a one-day network shutdown so that its naming conventions could be changed to follow the domain name system specified by the IETF.

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B

Getting Started

Part I: California Online Resources for Educators (CORE) and Graphical Interface for Network Access (GINA)

In response to a need to provide California teachers and students diversified information resources, the California Technology Project (CTP)[1] established California Online Resources for Education (CORE) in 1989. CORE is an online information resource service which includes access to electronic mail, bulletin boards, research data bases, and curriculum exchange conferences. In addition, CORE provides a gateway to hundreds of other information services that are available via the Internet. Currently there are approximately 20,000 K–12 subscribers using CORE (membership is continually increasing). Although CORE is not a direct Internet connection, it has provided a cost-effective and easy way for educators throughout the state to reach the Internet.

Access to CORE is primarily available through CSUnet, a multi-million dollar electronic network which supports the twenty California State University campuses. This backbone network has been made available to K–12 educators by CSU; CSU has also provided much of the substantial developmental resources needed for the establishment of the CORE network. Educators accessing CORE pay for the telephone call from their local site to the nearest CSU campus; there are no additional charges for access to information.

Most recently, CTP has developed a graphical user interface called GINA (Graphical Interface for Network Access). This interface package provides user-friendly access to services including: electronic mail, conferencing, bulletin boards, databases, library catalogs, and other information resources. GINA provides a common interface across all these functions (e.g., similar menus, toolbars, and other interface components). GINA package permits transmission of complex documents between software packages and across operating systems and hardware platforms. GINA places special emphasis on access to educational resources, while limiting access to resources in other Internet domains.

Unlike the search and retrieval tools discussed in Part III, Chapter 7, Internet Services, GINA is not available to users for free.

[1] The California Technology Project was authorized under the provisions of AB 803, the Farr-Morgan-Quackenbush act of 1988, and was reauthorized in 1992 as part of the Morgan-Farr-Quackenbush Educational Technology Act of 1992 (SB 1510). The Act specifies that the Superintendent of Public Instruction provide "support for the statewide coordination, administration, and evaluation of collaborative educational technology programs and resources among regional groups, institutions of higher education, school districts, businesses, and other agencies."

GINA can be used with either Macintosh or IBM Compatible systems in accordance with the following specifications:

MACINTOSH:

System 7.0 or later
Minimum 4MB RAM
Minimum 2MB hard disk space available
9600 BPS v.32 or better modem or
Ethernet/LocalTalk IP connection
GINA supports the following protocols:
POP3 (for receiving mail)
SMTP (for sending mail)
NNTP (for NetNews)
Gopher (for information access)
Telnet (for remote logins)
CSO/PH (for phone directories)

IBM:

Microsoft Windows 3.0 or better
386 or 486 processor
Minimum 4MB RAM
Minimum 2MB hard disk space available
Mouse

For more information regarding CORE and GINA, contact the Chancellor's Office, California State University, by phone at (800) 272-8743; by FAX at (310) 985-9400; or by email to gina@calstate.edu.

Part II: Selecting Dialup Connections

From *Connecting to the Internet*,[1] (Susan Estrada 1993)

- Online Accounts
- What Kind of Connections Are Available?
- SLIP and PPP CONNECTIONS
- Access Options
- Comparing Dialup Options
- Dialup Account Checklist of Questions

Dialup connections are appropriate for individuals and small businesses with low-to moderate-impact applications and budgets. Dialup connections vary widely in performance and price, so it's important to know what your needs are before you start looking at providers. If you are going to use your connection primarily for fun, you can put up with some performance quirks and save money. If you are going to use your connection for business purposes, you need a more stable connection.

What Kind of Connections Are Available?

There are two types of dialup connections: online accounts or dialup IP links. Dialup IP links are usually described by the particular protocol they are running: either Serial Line Internet Protocol (SLIP) or the more advanced Point to Point Protocol (PPP).

Both types of connections can give you a lot of things to do on the network. If you are starting your Internet adventure as an individual, an online account is easy to access and less expensive. If your usage is heavy, or if you have several people on a local area network (LAN), a SLIP or PPP connection becomes necessary.

[1]Our thanks to Susan Estrada and O'Reilly & Associates for permission to reprint this chapter from *Connecting to the Internet*.

If you have an an online account, you connect from your own computer, using a telephone line and a modem, just as you would connect to a bulletin board. An online account is one step removed from full Internet connectivity, though, and has some important limitations. If you have a SLIP or PPP account, you also connect through a modem over a phone line, but your computer runs TCP/IP software to talk the TCP/IP protocol. A SLIP or PPP actually puts your computer on the network, and gives you full Internet access.

Online Accounts

An online account is an account on a host computer that's connected to the Internet. To the host, your computer looks like a character-based terminal, and your communications software provides terminal emulation. (VT100 is a popular terminal type supported by most systems and most communications software.) When you dial into the host computer, you must log in and supply a password to get into your account.

Many of the public access providers run UNIX, where online accounts are referred to as shell accounts. (The shell is a program that you interact with by typing commands.) You may see a UNIX prompt, or you may go into a custom menu-based interface. One way or another, you can usually send and receive electronic mail. Most online accounts let you use programs like Gopher, WAIS, WWW, TELNET, FTP, or any other program available on the host. Some don't. All of the providers listed in Appendix B offer at least outbound TELNET and FTP.

The drawback of an online account is that it takes two steps to get data onto

your machine. You must download the data first to the host and then to your own computer (see Figure B-1). The FTP utility (File Transfer Protocol) is commonly used to retrieve data from the Internet and put it on the host. Then, to download it from the host to your machine, you can use one of the standard file transfer protocols like kermit, xmodem, ymodem, or zmodem. Another way is to use the screen capture feature (most communications software packages include this) to copy data as you view it on your own computer. FTP or other Internet-based applications do not run on your computer, as they depend upon the underlying support of the TCP/IP protocols to work.

Now, this "double download" can be a benefit in disguise. It lets you retrieve big data files (that might not even fit on your own disk) and look at them on the host. You can decide if you really want to the file on your local machine after you view it—you might copy only the piece of the file that you want. Downloading to the host can save the disk space on your own computer. (Of course, you may be paying for the amount of disk space you use on the host.)

Because you read e-mail, USENET News, etc. on the host machine, you are doing all of your data processing while you are online (connected to the host). Keep this in mind if you are paying by the minute for the time you spend online.

An online account can be useful if you travel a lot. You can log in to the host machine from different computers and different locations. Your special files, network addresses, or software will be available to you. For example, if you're traveling with a portable computer, consider a provider with an 800 number or nationwide local access numbers that you can use to dial into your online account.

Online accounts work well at any speeds up to the current modem standards. (See Chapter 2 for a listing of common modem standards.) Higher-speed modems or different access options (as opposed to regular telephone lines) allow your computer screen to update more quickly and also help keep your online time to a minimum. You may pay

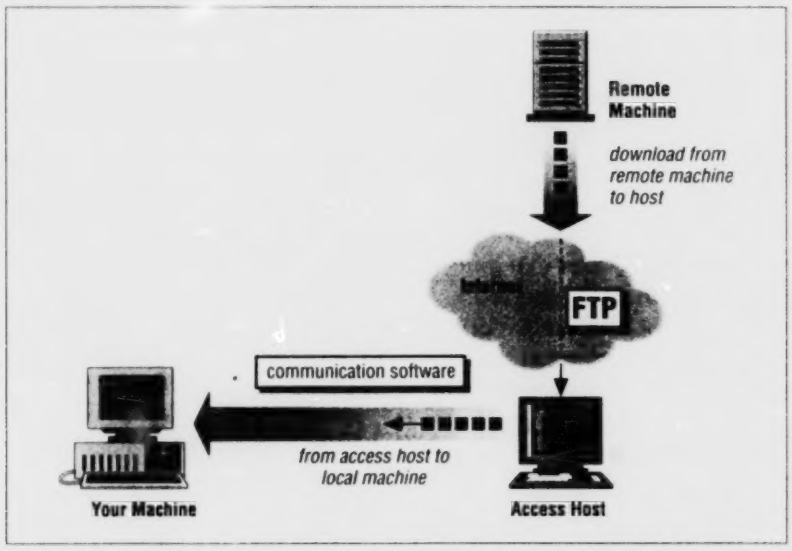

Figure B-1. Double download requires transferring file via FTP from the network and then downloading it to local machine using Xmodem or other communications.

a premium for access via a higher speed modem.

Online accounts work well for individuals or small businesses who want a simple, low-cost access to the Internet.

Equipment Required

Figure B-2 shows the equipment needed for a typical online account connection. At your site, you need a computer, a modem, communication software, and a regular phone line. (Many modems come with free software.)

On the supplier's side, you either go directly into the host computer, or you connect to a modem bank and then to a terminal server. A terminal server is a device that allows for multiple modem connections into the network. Most larger providers have a terminal server.

If you do go through a terminal server, you may need to perform a TELNET session to log in to the host. This is simple to do, especially if your communications software supports scripts. With a script, you go through the motions once; then the next time you log in the scripts, you remember where you went and how you got there.

If not included with your modem, communications software is available as freeware and shareware and through commercial sources. Common packages are:

- Macintosh: ZTerm, Microphone Pro, VersaTerm, MacIntercomm, SmartCom
- PC with DOS: Telemate, Telix, Procomm
- PC with Windows: Procomm Plus

Interface

Don't overlook what you see once you connect to the host. The user interface must be something you can use productively. Extras such as good email and news interfaces and custom menu-driven systems can have significant value if they

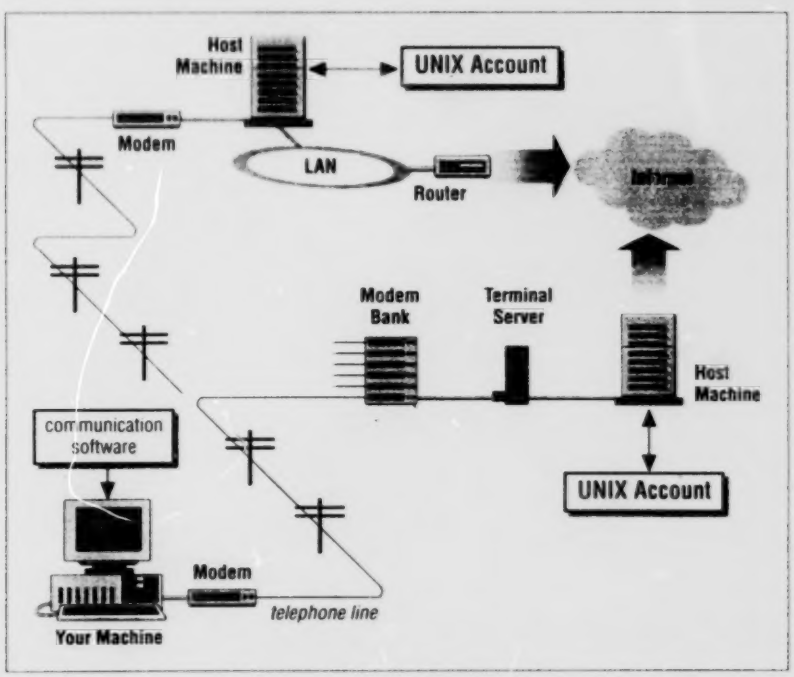

Figure B-2. A dialup connection requires a modem on your end and a phone line that connects to a modem connected to the host or to a terminal server.

save you time and improve your productivity. Check for software that simplifies your access to the Internet. Software programs can vary from command driven e-mail readers (you type in commands rather than use menus or icons) to graphical user interfaces (GUIs) that work like the operating system of your computer.

Figure B-3 shows an example of CERFnet's menu system that makes an online account easier to use.

Some providers stick to a basic prompt like:

nic%

Some have made it easier to navigate the network by simplifying basic functions. Others have made it very easy for you by providing an extensive help system online. The basic prompt can make you feel somewhat ignorant if you have had little or no prior experience with computer systems. With a good desk reference book, like Ed Krol's *The Whole Internet User's Guide and Catalog*, you can get along with a prompt, although it may seem challenging at times. If you are allergic to manuals or want to do as much as possible without one, look for a provider that has a menu interface or a good help system.

Installation

Presuming you have the correct equipment, installation of an online account is simple and quick. It is usually a matter of signing an agreement and receiving a telephone number to call, a login ID, and password. Some providers make it easy to sign up online, allowing immediate access to the Internet.

Additional Considerations

Network availability should be taken into account when choosing an online account. You have to be able to get access to an available modem line on the provider end, and you don't want frequent busy signals. Ask them how many modems are available. How often are they all busy? When will the provider add additional modems? Answering these questions will translate back to network availability—will you be able to log in when you want to? If you want to be sure that you always have immediate access, some providers have dedicated modem connections, which means that the modem line on their end is there for your exclusive use.

```
Internet  Compass          Main Menu                          v1.0

        A          Account Tools  - User Account Tools
        C          CERFnet Info   - CERFnet Info and News
        F          Files          - File Transfers
        G          Games          - Electronic Entertainment
        I          Internet       - Internet Search Tools
        M          Mail           - Electronic Mail
        N          News           - USENET News
        T          Telnet         - Remote Login to Other Systems
        U          UNIX Shell     - Escape to UNIX Shell Commands
        Q          Quit           - Exit
        ?          Help           - Help using Internet Compass
                      Enter Selection
```

Figure B-3. CERFnet's Internet compass screen

The amount of disk space allotted to each online account on the host computer varies considerably. This can present a real problem if upgrade options are not available. If disk space is limited on the host, you may not be able to transfer files or store email. During the preparation of this book, I had to increase my disk space allotment to handle the volume of file transfer underway. Some providers have a shared storage area available for temporary transfers while doing double downloading. Find out how much disk space you will be allotted and what it will cost to expand it if necessary. One megabyte of space is the minimum you want. Ask if a temporary area is available for use.

The total number of simultaneous users on the host computer can also be a performance factor. If a supplier tries to support too many simultaneous users, the host computer slows down, causing delays to users doing routine tasks.

Cost

Most service providers have flat rates or hourly usage charges. There are networks who have a flat rate for a fixed amount of hours or for usage within certain hours. Evaluate your needs thoroughly then compare costs. If you'll be using your connection during evening and weekend hours, check for special rates during these hours.

Be careful when evaluating different costs. Some online accounts won't allow use of anything but email and USENET News. If you want to use Gopher, TELNET, etc. you have to upgrade to a higher-priced account. In order to correctly evaluate cost versus benefit, ask what applications are included.

Figure B-4 helps you compare costs among providers. To make the best cost comparison, estimate the time you will spend online. Light Internet users typically are online from five to 15 hours per month. Medium Internet users are online 20 to 50 hours per month. If you are a heavy Internet user, don't worry about how much time you are online; find a connection for a fixed price.

The comparison in Figure B-5 assumes that a user would connect during business hours, Monday through Friday, for one hour per day. In comparing the five networks, we used the criteria listed at the end of this chapter. XYZNet, the cheapest, had busy signals over a period of time when I wanted to log in to check disk space allotments. It was disqualified due to lack of adequate dialup facilities.

All of the listed parameters were taken into account, using "local access" telephone numbers. After factoring in the toll charge from the "local" numbers, there were surprising results. At first glance, the apparent low cost solution was ABCnet, with a monthly charge of $20 for unlimited usage. Unfortunately, its "local number" toll charges added up to a whopping $11.49 per hour. Instead of being the lowest cost solution, it was the most expensive choice. 123net was the winner, even though billing was done on hourly usage. TollFreenet was the runner up. X.25Net had a hefty hourly charge for access to a 2400 bps modem and was thus disqualified.

SLIP and PPP CONNECTIONS

With a SLIP or PPP connection, your own computer has a full Internet connection capable of sending and receiving data from other computerson the network. You can run networking applications (such as email, FPT, WAIS, and WWW) locally on your computer. Another benefit of a SLIP or PPP connection is the fact that you can open up multiple sessions, allowing simultaneous interaction with different computers on the Internet. In one window you could be running an FTP session while you are using Gopher in another. You can set up your system so that email can come directly to it. The option to use your own

Cost Comparison - Online Account

Service Provider	Setup Fee	Fixed Monthly Charge	Hours Included	Extra Hourly Charge	Other Costs	Toll Charge Incurred	Estimated Monthly Cost
1							
2							
3							
4							
5							
6							
7							
8							
9							

Assumed Time On-line: _____

Comments:

Figure B-4. Cost comparison—online accounts

Cost Comparison - Online Account

Service Provider	Setup Fee	Fixed Monthly Charge	Hours Included	Extra Hourly Charge	Other Costs	Toll Charge Incurred	Estimated Monthly Cost
1 ~~XYZnet~~	~~10~~	~~15~~	~~unlim.~~	~~0~~	~~0~~	~~0~~	~~15.00~~
2 123net	60	10	0	6	0	0.61	131.60
3 ABCnet	15	10	unlim.	0	0	8.49	149.80
4 TollFreeNet	16	16	0	8.5	0	0	196.00
5 X.26Net	0	6	0	8.6	0	0	126.00

Assumption: 20 hours per month of online time (1 hour per day)

Figure B-5. Sample cost comparison—online account

domain name is an important consideration.

SLIP and PPP should be used with a modem capable of at least 9600 bps, with 14.4 kbps preferred. A SLIP or PPP connection can have difficulties with certain types of compression. Check with your supplier for recommendations regarding specific settings for your modem.

One of the drawbacks of a SLIP or PPP connection is the initial difficulty in configuring the software. I have spoken to many frustrated users during the setup process who have been ready to give up after a week or two of problems. In the end, they usually were successful in connecting. In order to use a dialup IP connection, plan on having to learn more about TCP/IP and configuration issues. A lot can be said for good documentation and technical support, and a good friend who can walk you through the process.

Equipment Required

Figure B-6 shows the hardware needed in a SLIP or PPP connection. TCP/IP software runs on the computers accessing the router, and the SLIP or PPP software runs on the router itself. There are many implementations of SLIP and PPP software available. Table B-1 lists a few commerical packages. The support provided by SLIP/PPP software vendors and

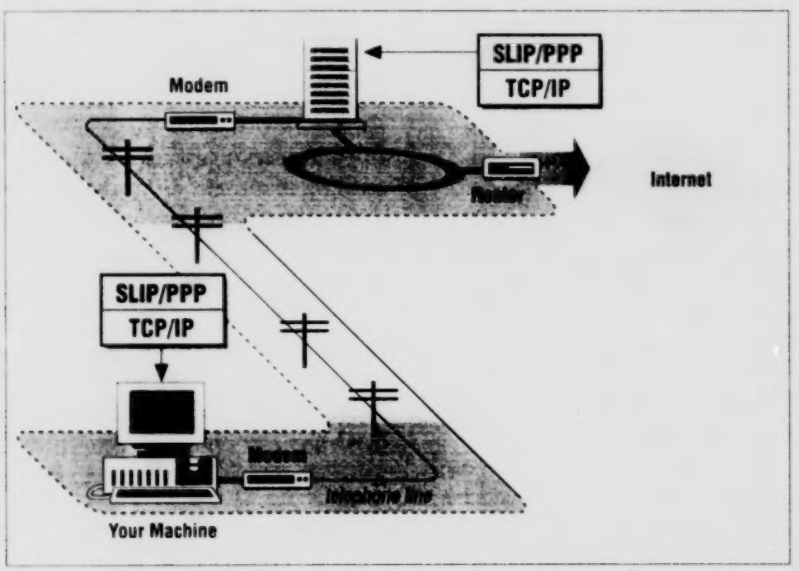

Figure B-6. A SLIP/PPP connection allows your machine to be part of a local area network.

Table B-1. Commerical SLIP Software

System	*Package*	*Company*
PC Dos and Windows	Chameleon	Netmanage
PC Dos and Windows	SuperTCP	Frontier Tech Corporation
Macintosh	Versatilities	Synergy Software
Macintosh	MacSLIP	Trisoft
Unix	Morningstar PPP/SLIP	Morning Star Technologies

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the improved reliablity of commercial implementations are often worth the money spent ($100-$700).

Another option for SLIP and PPP connections is a SLIP/PPP router. This setup works better for LANs because each computer doesn't have to have a modem. (Also, you don't have to configure your own SLIP or PPP software.) The router handles the dialup setup for you, which means that except for a dialing delay while the computer "talks" to the router, the connection appears the same as a dedicated line.

A number of hardware vendors are building routers, which include modems and SLIP or PPP software. Two examples are the NetHopper from Rockwell International and the NetBlazer from Telebit. They can be easily attached to a computer for a simple Internet connection. Many of the network providers will sell or rent the routers. They will usually configure the router to work with their network, providing an easy solution for Internet connectivity. A router solution is practical for small businesses. This solution is still expensive for individuals ($1500 list) when compared to a software plus modem configuration.

Installation

As noted, the installation of SLIP and PPP can be a painful process. This can be minimized by working with a knowledgable provider who will provide technical help and moral support during the installation. In order to set up a SLIP or PPP account, you should have the following information available:

- TCP/IP address (from the provider)
- Domain name if wanted (for registration forms, contact Internet Domain Registry at rs.internic.net)
- Domain name and address of the primary and secondary name server (from the provider)
- Subnet mask (from the provider)
- Size of the maximum receivable unit
- MRU (from the provider)
- SLIP or PPP software or router
- TCP/IP software

Getting signed up for a SLIP or PPP account is simple and quick. It will usually involve some kind of agreement or contact, especially if you are using a router from the provider.

Options

Deciding between SLIP and PPP is important. Another SLIP option called CSLIP is also available. CSLIP, compressed SLIP, compresses the IP address information in data, thus making file transfers faster. If you will be doing many large file transfers, you should consider CSLIP. A provider's equipment will usually support only one option: either SLIP, CSLIP, or PPP. If you feel strongly about using one type of software, ask the provider if that option is available.

Another option to track is the availability of a static IP address. This will allow you to have your own domain name. Some providers use dynamic addressing which will keep you from using your own domain name. If you are going to dialup different SLIP servers and you have a static IP address, you will need a different IP address for each server and have to change your configuation.

Cost

Most service providers have flat rates for SLIP and PPP services. A few have hourly usage charges. The jump in cost from an online account to SLIP or PPP can be large. The flat-rate services are typically ten times the cost of online accounts. If you'll use your connection during evening and weekend hours and purchase an hourly rate service, check for specials on rates for off-hours.

Figure B-7 helps you compare costs among providers for SLIP or PPP connections. Remember to estimate the time you will spend online: light (five to 15 hours

per month), medium (20 to 50 hours per month), or heavy (above 50 hours per month).

The comparison in Figure B-8 assumes that a user would connect during business hours, Monday through Friday, for two hours per day. Four networks were compared using the criteria listed at the end of this chapter. As in the comparison of online accounts, the hidden extra cost of toll charges to "local" dialup numbers ended up as the overriding cost con-

SLIP/PPP Cost Comparison

Service Provider	Setup Fee	Fixed Monthly Charge	Hours Included	Extra Hourly Charge	Other Costs	Toll Charge Incurred	Estimated Monthly Cost
1							
2							
3							
4							
5							
6							
7							
8							
9							

Assumed Time On-line: _____

Comments:

Figure B-7. SLIP/PPP cost comparison

Cost Comparison - Online Account

	Service Provider	Setup Fee	Fixed Monthly Charge	Hours Included	Extra Hourly Charge	Other Costs	Toll Charge Incurred (per hr.)	Estimated Monthly Cost
1	XYZNet	10	176	unlim.	0	0	1.46	171.00
2	123net	60	10	0	5	0	1.46	318.00
3	ABCnet	16	160	unlim.	0	0	11.49	379.80
4	TollFreeNet	16	10	0	8.6	0	0	360.00
5								

Assumption: 40 hours per month of online time (2 hours per day)

Figure B-8. Sample SLIP/PPP cost comparison

sideration. XYZNet, with a fixed monthly cost and a relatively inexpensive toll charge, was the winner. 123Net came in second, with hourly usage charges. If usage was to drop by 15 minutes per day, XYZNet and 123Net would cost the same. If usage were to increase substantially, XYZNet would be the obvious choice.

Access Options

In addition to regular telephone lines, there are two other popular methods for dialup access: ISDN and X.25. In both cases, network providers need to have special connections installed to support access via these methods. Another consideration for access is the availability of local or toll-free access numbers.

ISDN

One alternative access method for dialup is the Integrated Services Digital Network (ISDN). ISDN lets you use a special telephone line for data and voice simultaneously, which can be cost-effective. ISDN offers higher speeds over a digital link and a better quality connection than with modems. To use an ISDN connection, you need a piece of equipment that substitutes for the modem. Some workstations have ISDN equipment built into the computer. Otherwise, the ISDN interface device has a price tag between $1000 and $1500, a major stepup from inexpensive modems.

ISDN has been slowly spreading throughout the US, and not everybody can get it. If you are not near a major city or your phone company has older equipment, you may have to wait years before ISDN is available. (Your phone company should have a number to call for the ISDN "deployment schedule" for your area.)

An alternative that is currently available is called Switched 56k (SW56k). This is a switched data-only service that runs at 56 kbps ("Basic Rate Interface" ISDN lets you run up to 128 kbps of data or voice). It is very much like a phone call in that it uses a normal looking phone number and takes a little while to connect (whereas ISDN connections are very quick to set up). SW56k requires special wiring and uses different lines than voice lines (whereas ISDN uses normalvoice lines). It is a metered service, meaning you pay by the minute (or second), and long distance costs more than local calls. If you are us-

ing it for an Internet connection, you should use equipment that only dials up when there is data to send. If the SW56k service is used often enough, there is a point at which it becomes more cost-effective to have a dedicated 56K connection (DDS) line. The biggest advantage of SW56k is that you can call multiple locations using phone numbers, while a dedicated service ties you to a single location. This type of service would be perfect for a print shop or service bureau where customers use SW56k (or ISDN) to submit printing jobs.

ISDN offers a data rate up to 128 kbps, adding together two 64 kbps channels (called "bearer channels" in ISDN-speak). Each channel can carry voice or data, so you could have a voice call on one channel and a 64 kbps data connection on the other. Sites with ISDN can usually call sites that use SW56k, but their data rate would get chopped from 128 kbps to 56 kbps. Some phone companies are offering "single line" ISDN (possibly called "IS") which is a single 56 kbps connection. You might encounter another situation where each ISDN channel is only 56 kbps, yielding a combined data rate of 112 kbps. Check with your local phone company for their ISDN offering.

X.25

The other dialup option is an X.25 network. With an X.25 connection,you need the same equipment as you would with a normal dialup connection. While you may think of an X.25 connection as a regular telephone line, you may notice slower performance, such as a delay in seeing what you have typed. Popular X.25 networks are TYMNET and SPRINTNet. X.25 is not recommended for a SLIP or PPP connection. The additional routing information added to normal TCP/IP means X.25 links have dismal performance. However, modem connections using X.25 are quite affordable at this time.

When is long distance cheaper than a local call?

If you look at the dollars per byte tranferred, X.25 networks tend to be more expensive than direct dial long distance or 800 number services. The reason for this is two-fold. First, X.25 is usually only 2400 bps, so it will take longer to transfer data. Second, you are paying for two connections, once to the X.25 provider and once to the Internet provider. It is easy to pay $10 per hour for 2400 bps service, a high price for a slow connection.

Toll-free Versus Local Access Numbers

Finding a local phone number at the speed you want may save you large amounts of money. Some Internet providers also offer toll-free 800 numbers and bundle the cost of your call in their total charges to you for the Internet connection. While the provider's charges for such toll-free numbers may look expensive at first glance, they may save you money if you don't have a local phone number to call. Toll-free numbers are especially useful if you travel a great deal and don't want to remember (or look up) the local telephone numbers. When you are comparing the cost of 800 number service with local service, check for any toll charges you may incur from dialing the provider's closest local telephone line. You can get rates from the front of your phone book or by calling your telephone company. I was very surprised when I learned that a call from my home to my local node, a distance of 15 miles, cost $2.50 per hour. Of course, if you are not charged by message units for a local call, and your connection is local, then you can stay logged in all the time for a fixed monthly cost.

Comparing Dialup Options

You should consider whether you can upgrade from an online account to a SLIP or PPP connection. This is important if you anticipate expanding your organization. Some providers have interchangeable accounts, where you can have either type of connection. Some require different methods of access between the two. Check to see if there will be additional fees if you upgrade from an online account to a SLIP or PPP connection.

Find out when the provider does scheduled maintenance of the terminal server or host computer. Make sure that it is not down during a time when you need Internet access.

Dialup Account Checklist of Questions

Online Accounts

Do I have the required equipment configuration?

Do I need or want the added benefit of a menu-driven system to simplify online access?

How often does the provider experi ence busy signals?

What is their procedure for adding additional modems?

How much disk space do I get? How does this compare with other providers?

Is the host computer congested (slow)?

Is there a local number to dial?

Is a toll-free number an option?

Is there ISDN access?

Is there X.25 access?

Can I upgrade to SLIP/PPP for no additional charge?

When is maintenance scheduled on the terminal server and modems? Host computer?

What is the real cost of the connection? (See Figure B-4).

SLIP or PPP Accounts

Do I want to connect one computer or a LAN?

Do I have the required equipment configuration including software?

Do I want to learn more about TCP/IP?

Do I have the time to set up a SLIP or PPP connection? If not, can I get help from the provider?

Do I have a domain name?

Does the provider do static or dynamic addressing?

How often does the provider experi ence busy signals?

What is their procedure for adding additional modems?

How much disk space do I get? How does this compare with other providers?

Is the host computer congested?

Is there a local number to dial?

Is a toll-free number an option?

Is there ISDN access?

Is there X.25 access?

When is maintenance scheduled on the terminal server and modems?

What is the real cost of the connection? (See Figure B-7).

C

Internet Access Providers for Education Agencies in California

"Prepared by Cooperative Library Agency for Systems and Services (CLASS), with partial support from Federal Library Services and Construction Act funds. Administered in California by the State Librarian."

Compiled By Bennett J. Price, Ph.D.

The tables below present information about suppliers of Internet access, i.e, providers of the computing and telecommunications equipment and services needed to permit individuals or institutions to gain access to the Internet. Since this report was funded by an LSCA grant administered by the California State Library, it focuses on the information needs of California libraries and information agencies. (Please see the disclaimer on page 126.)

The pool of potential suppliers was culled from:

- The list of regional, national and international service providers in Ed Krol's *The Whole Internet: User's Guide & Catalog* (California, 1992), pp. 340–347);
- The electronic PDial list compiled by Peter Kaminski;[1]
- The electronic Network Provider Referral List compiled by the National Science Foundation's Network Service Center;[2]
- Chapter 4 ([Domestic] Service Providers) of SRI's "Internet: Getting Started";[3]
- The electronic Open Access Unix Sites (nixpub) List.[4]

Two tables are presented. The first provides information about suppliers of straight-forward (asynchronous) dialup service; this is the sort of service that librarians have long used to query, e.g., DIALOG and BRS. The second table presents information about other, more elaborate, faster, and complicated methods of connection, including leased lines and routed circuits.

[1] To receive the newest edition, send email to: info-deli-server@netcom.com. In the Subject Field, put SEND PDIAL. To receive it regularly, put SUBSCRIBE PDIAL in the subject field. This list is regularly posted to, inter alia, alt.internet.access.wanted and alt.bbs.lists. It can be anonymously FTP'd from, e.g., vfl.paramax.com (128.126.220.104) as /pub/pubnet/pdial.

[2] This list has been superseded by the "InterNIC Directory of Directories - Network Provider" list. The document can be FTP'd from ds.internic.net. Get dirofdirs/provider/0intro.provider first, as it provides a table of contents to the many individual parts.

The list can be FTP'd from nnsc.nsf.net as nsfnet/referral-list.

[3] This can be FTP'd from ftp.nisc.sri.com as: netinfo/internet-access-providers-us.txt.

[4] The nixpub list, a compilation of free and for-fee public Unix machines, most of which are connected to the Internet and variously provide mail, ftp, and telnet services. The list is posted regularly to alt.bbs.lists, e.g, and can be FTP'd from: ashley.cs.widener.edu as /pub/nixpub/long.

The criteria for inclusion were:

- Minimum Services–Must provide Telnet, FTP and mail services.
- Point of Presence (POP)–Dialup services must provide a California area code or area code in a state contiguous to California (i.e, AZ, NV, OR) and/or 800 service and/or a packet switched network that can avoid the need to make long distance calls.

Similarly, dedicated line service providers in AZ, NV, and OR were considered for inclusion.

The tables do not pretend to completeness. The dialup table, for instance, only cites suppliers' simplest, least-expensive, low-use offering. Suppliers may or may not have offerings better suited to institutions, multiple users or passwords, and heavy use. Note that the rates cited are not only for the least expensive service options but also for the least expensive billing options, typically a prepaid deposit account or an automatically billed credit card with no invoice.

The phone numbers listed in the "Supplier" column are for voice. The Email addresses cited there are generally for an automated information service; while they may not be read by a person they will provide information about how to send mail to a supplier's representative. In the "Other Services Provided" column, only services likely to be of general interest to librarians have been noted. Access to public and private bulletin-board services beyond those generally available on the Internet, FTP and news archives, supercomputers and Unix software development facilities are passed over in silence. The availability of UUCP connections, offered by many suppliers at extra cost, is not noted either.

N.B. The information comes primarily from suppliers' sales literature and brochures (propagated both on paper and online) and was in many cases supplemented by telephone and email conversations with suppliers. Suppliers have had the opportunity to review, correct, and amend the information presented (although not all have chosen to do so), but it has *not* been independently verified. CLASS has not attempted to determine the dependability, reliability, or financial stability of any of the suppliers listed and cannot take any responsibility for any errors or omissions.

This study is produced by CLASS, the Cooperative Library Agency for Systems and Services. CLASS was established in 1976 as a Joint Exercise of Powers Agency by the California State Library, the University of California, the California Community Colleges, the California State University, the City of Los Angeles, and the County of Santa Clara. CLASS is a membership-based self-supporting public agency formed for the purpose of library cooperation. CLASS acts as a service broker to its worldwide membership of libraries and information agencies, both public and private.

These documents on Internet Access Providers for California Libraries are part of a larger project: *Internet: Planning and Training for California Libraries*, a project supported in whole or in part by the U.S. Department of Education under the provisions of the Library Services and Construction Act (LSCA), administered in California by the State Librarian. Please note, however, that the opinions expressed herein do not necessarily reflect the positions or policy of the U.S. Dept. of Education or the California State Library, and no official endorsement by either should be inferred. CLASS cannot take responsibility for any errors or omissions.

Dialup Internet Access Providers

Supplier	*Other Services Provided beyond Mail, FTP, & Telnet @ 2400 baud*	*Membership fees & periodic charges*	*a) Usage, b) Storage, & c) Other Charges (Telephone charges, see next column)*	*Telephone Charges /Area codes*	*Customer Support, Training, Documentation & User Aides*
a2i communications 1211 Park Avenue # 202 San Jose, CA 95126 Vox 408-293-8078 info@rahul.net	UseNet News 14.4K & Telebit PEP® 19.2K dialup @ no extra charge. SLIP & PPP will soon be offered.	No setup fee. From $12 to $20/mo per person depending upon length of prepayment ($12/mo. for 6 mos.)	a) No connect charges. b) 5MB disk space free.	No 800# service available. Pay telco for calls to San Jose (408-293).	Online & voice-mail from 9am to 1am daily. No training or printed documentation. Simple mailer but no menu system available.
CERFnet Box 85608 San Diego, CA 92186 Vox 800-876-2373 help@cerf.net	UseNet News 14.4K & Telebit PEP® 19.2K dialup @ no extra charge. SLIP	$50 organizational setup fee. $20 /mo/acct.	a) Peaktime (5pm Sun to 5pm Fri) @ $5/hr. Offpeak @ $3/hr. b) 1MB private storage free; unlimited temporary (common) storage.	800# @ $5/hr or pay telco for calls to area codes 310, 415, 510, 619, 714, 818.	24/7 800# & Email network support. Printed documentation and training available. Simple mailers, library-oriented menu system & tools available.
CLASS 1415 Koll Circle # 101 San Jose, CA 95112 1-(800)-488-4559 class@class.org	News 14.4K & Telebit PEP® 19.2K dialup @ no extra charge. SLIP Free demo available.	$135 membership/yr. $150/yr. for 1st password, $50/yr. for each additional password. Other pricing options available for 10 passwords.	a) $4.50/hr. b) 1MB private storage free; unlimited temporary (common) storage.	800# @ $6/hr. or pay telco for calls to area codes 310, 415, 510, 619, 714, 818.	24/7/ 800# Email netwrok support. Printed documentation & training available. Simple mailers, library-oriented menu system & tools available.
CSN Colorado supernet, Inc. CO School of Mines 1500 Illinois Golden, CO 80401 Vox 303-2733471	Usenet News 14.4 dialup @ no extra charge. SLIP $ PPP $100	$20 for 1, $100 for 10, $500 for 100	a) $3/hr peak; 1$/hr midnight-6am. No charges after $250/mo/loginid b) 1 MB free; then $.50/MB/mo.	800# @ $11/hr or pay telco for calls to colorado.	Help available M-F 7-4:30 PST. Printed documentation available. Menu system and simple mailers available. Extensive K-12 & Library services.
CRL Internet Service Box 326 Larkspur, CA 94977 Vox 415-381-2800 info@crl.com	Usenet News 14.4 @ no extra Charge; ISDN & switched 56K available SLIP & PPP $150/mo.	$19.50 setup fee $17.50/mo.	a) No connect charges. b) 5 MB disk space free; then $2/MB/mo.	800# @ $8-12/hr (depending on time of day) or pay telco for calls to areacodes 404, 415, 510, 602, 707.	Support available 24/7 via email; via phone M-F 8-5. Simple editor and mailer available. Business accounts @ $45/mo.

Supplier	Other Services Provided beyond Mail, FTP, & Telnet @ 2400 baud	Membership fees & periodic charges	a) Usage, b) Storage, & c) Other Charges (Telephone charges, see next column)	Telephone Charges /Area codes	Customer Support, Training, Documentation & User Aides
CSUnet California State University Information Resources and Technolgy 4665 Lampson Ave Los Alamitos, CA 90720 (310) 985-9669 (Fax)(310) 985-9400 chris@csu.net	Usenet News, Feed (NNTP) Dialup limited to CSU and CDE special projects. Expanded coverage and options expected 2nd half of 1994.				
CTSNET CTS Network Services 1274 Vista Del Monte Drive El Cajon, CA 92020 Vox 619-593-9597 info@crash.cts.com	Usenet News, Reuters, Clarinet 14.4K & Telebit PEP@ 19.2K dialup @ no extra charge. SLIP & PPP $5/mo.	$15 setup fee. $18/mo.	a) Monthly charge assumes 1hr/day use. b) 1MB mail storage, 2 MB private work storage; then $.20/day/MB of email, $.30/day/2MB private work storage.	No 800# service available. Pay telco for calls to (619)-220,593,729.	Email and phone support M-F 10-6; 24/7 emergency support. Some printed materials available. commercial accounts available starting at $25/mo.
Cyberspace Station 204 N. El Camino Real # E626 Encinitas, CA 92024 Vox 619-944-9498 x 626 robb@cyber.net	Usenet News 14.4K @ no extra charge. SLIP and/or PPP in future.	$10 setup fee. $20/mo or (6 mo/$90 paid in advance) for 1hr/day	a) Monthly fee covers 1hr/day usage; 2 hrs/day is 2x as much. b) 1MB private storage free; unlimited temporary (common) storage.	No 800# service available Pay telco for calls to (619)-634.	Mostly by email; phone support "most evenings" from 7pm "till wee hrs. of morning." No printed documentation or training available. Simple mailer but no menu system available
Delphi General Videotex Corp. 1030 Massachusetts Ave. Cambridge, MA 02138 Vox 800-695-4005	Usenet News Unsupported 9600 baud @ no extra charge via Sprintnet in many cities. Low-cost trial account	Either: $13/mo. or $23/mo.	a) @$13/mo, 1st 4hrs free, then $4/hr. @$23/mo, 1st 20hrs free, then $1.80/hr. b) 25KB disk storage free; then $.16(sic)/KB/mo.	No 800# service available. Pay surcharge to Delphi (for Tymnet or Sprintnet) $9/hr M-F 6-7 am to 6-7pm, off-peak no surcharge. or Pay telco for calls to Kansas City.	Phone support available M-F 5 am-8pm, S-S 9am-5pm PST. Printed manual available. Menu system, simple mailer & editor available. Shareware PC & Mac compatible telecomm. software available.
Holonet Information Access Technologies 46 Shattuck Sq. #11 Berkeley, CA 94704 Vox 510-704-0160 info@holonet.net	Usenet News, USA Today, etc. 14.4 KB @ no extra charge via (510)-704. 9600 baud available from some locations. Free demo available.	No setup fee. $6/mo. (+ hourly charges or $60/yr.) which will be credited to connect and usage charges.	a) Connect @ $4/hr peak, $2/hr offpeak (peak=M-F 8-5). b) 256KB disk storage free, then $1/MB/mo c) Data transfer - 1MB/hr free, then $2MB/hr during peak, $1MB/hr during offpeak.	No 800# service available. Pay telco for calls to Berkeley (510-704) or pay Holonet from $.95 to $7.50/hr during peak ($.50 to $3.75/hr offpeak) for connections to area codes thruout AZ, CA, NV, & OR (USA). Max speed varies from 2400 to 9600 baud depending on location.	Phone support available "most hours." 24 hr. Email support. Online, but not printed, help & documentation available. Custom menu-driven system - (Unix shells are unavailable). Desktop sofware available for reading: Mail - Eudora (for Mac) mail & news - QWK (for PC).

Supplier	*Other Services Provided beyond Mail, FTP, & Telnet @ 2400 baud*	*Membership fees & periodic charges*	*a) Usage, b) Storage, & c) Other Charges (Telephone charges, see next column)*	*Telephone Charges /Area codes*	*Customer Support, Training, Documentation & User Aides*
Meta Network network Metasystems Design Group, Inc. 2000 N. 15th St. #103 Arlington, VA 22201 Vox 703-243-6622	Usenet news 14.4Knb direct dial @ no extra charge. 9600 baud Sprintnet available in many cities @ no extra charge.	a) $15 setup fee (includes 1st mo. usage). b) $20/mo.	a) No connect charges	No 800# service available. Pay telco for calls to 703 or pay Metasystems $6.75/hr (for Sprintnet).	800 # support M-F 6am-3pm PST; 24/7 Email support. Printed Buide available. Menus and simple mailers available
Netcom Netcom Online Communications Services 4000 Moorpark Ave # 209 San Jose, CA 95117 Vox 408-554-8649 info@netcom.com	Usenet & Clarinet News 14.4KB @ no extra charge. Slip (personal) @ $17.50/mo + $2/hr.	$20 setup fee. $17.50/mo.	a) No connect charges. b) 5MB private storage free, then $2/MB/mo.	No 800# service; pay telco for calls to area codes 202, 206, 213, 214, 310, 404, 408, 415, 503, 510, 617, 619, 714, 818, 916.	E-mail & phone M-F 9-5. Other plans with more extensive help and support are available.) Online help and printed documentation available. Menus and simple mailer available
Pathways Pandora Systems 1903 Broderick #4 San Francisco, CA 94115 Vox 800-758-4777 Info@path.net	Usenet News 14.4 Kb direct dial @ no extra charge; 9600 baud Sprintnet available in many cities @ no extra charge.	$25 setup fee. $8/mo.	a) See next column.	Pay telco for call to 415 & $3/hr. or (via Sprintnet) pay $8/hr. peak (M-F 7am-6pm) or $5/hr. offpeak.	E-mail & phone M-F 9-5; help often available at other times. Printed documentaiton soon avilable. Menus now, simple editor and mailer soon available.
Portal Online Service Portal Communications Co. 20863 Stevens Creek Blvd. #200 Cupertino, CA 95014 Vox 408-973-9111 info@portal.com	Usenet News 14.4K and Telebit PEP® 19.2K are available @ no extra charge via (408)-973. SLIP/PPP available soon.	$20 setup fee. $20/mo.	a) No connect charges. b) 100KB disk storage free, then $.04 (sic)/KB/mo.	No 800# service; pay telco for call to (408)- 973 & (415)-965 or pay (for 9600 baud maximum) $7.50 to $10/hr (M-F 5am-6pm) ($2.50/hr offpeak) for connections to area codes throughout AZ, CA, NV, OR, (& USA).	Customer support available by Email, online, & phone M-F 9-5 with less than 24 hr turnaround. User's Guide, Nutshell Handbook & extensive online help is available w/o charge. Menus, forms, and simple mailer available, as is Eudora for Mac Unix shell users.
PSI Performance Systems International 11800 Sunrise Valley Dr #1100 Reston, VA 22091 Vox 800-827-7482 info@psi.com	Mail, ftp, (& Usenet News) provided by PSILink Basic Service(PSI-B); 9.6 KB available. Telnet provided by World Dial Service (WDS); 14.4 KB available.	PSI-B: $19 setup fee. $19/mo for 2400 baud, $29/mo for 9600 baud. WDS: $39 setup fee. $9/mo. minimum usage fee.	a) PSI-B: No connect charges. WDS: 2.4/9.6/14.4KB-Peak hrs (M-F 5-5 PST $2.75/4.50/6.50/hr Off Peak $1.25/3/4/hr. b) Assumes all mial, News, and ftp'd files are stored on user's PC or Mac.	No 800# service available. PSI-B & WDS: pay telco for calls to (213)-623, (408)-481&986, (415)-967&777. or PSI-B only: pay PSI $6/hr peak rate (8am-8pm), $2.50/hr offpeak for area codes throughout AZ, CA, NV, OR (& USA).	Email (24/7) and phone (M-F 4am-7pm PST). Training and printed documentation available. PSI-provided desktop-software for PC's and Macs provides menus, mailer, and help for PSILink-Basic service.

Supplier	*Other Services Provided beyond Mail, FTP, & Telnet @ 2400 baud*	*Membership fees & periodic charges*	*a) Usage, b) Storage, & c) Other Charges (Telephone charges, see next column)*	*Telephone Charges /Area codes*	*Customer Support, Training, Documentation & User Aides*
The Well 27 Gate Five Rd Sausalito, CA 94965 Vox 415-332-4335 support@well.sf.ca. us	Usenet News 9600 baud (via direct dialup at extra $2/hr.); no hi-speed surcharge for 9600 via CPN.	No setup fee. $15/mo. PC-Pursuit: $30 setup fee.	a) $2/hr (1st 5 hrs free). b) .5MB disk storage free; then $20 (*sic*) MB/mo.	Compuserve Packet Network (CPN) @ $4/hr (available throughout AZ, CA, NV, OR (& USA), many sites up to 9600 baud) or pay telco for calls to Sausalito (415-332). PC-Pursuit (2400 baud max.). @ $30/30hr/mo available during off-peak (M-Th 6pm-7am, F 6pm-M 7am).	Fax, online, & M-F 8-6 by phone. No training but 300 p. manual is available. Some PC & Mac desktop software available to aid in reading & navigating; contact Well for details. Simple mailer, interactive guided tour & some menus available.
WLN 4224 6th Ave, SE. Bldg 3 - PO Box 3888 Lacey, WA 98503 Vox 800-342-5956	9600, (14.4k?) SLIP WLN database Free demo available.	$50 1st time setup fee for any # of accts. @ same billing address; $25 for later setups or other billing addresses 1st acct.$275 /yr; addit'l accts @$150 yr.	When not using 800#, 1st 20/hrs/mo free, then $2/hr. or See next column	Pay telco for calls to area code 206. or $8.50/hr (includes both 800# service & online time)	800# phone support User manual. Menu-driven mailer, library-oriented tools available.
The World Software Tool & Die 1330 Beacon St. Brookline, MA 02146 Vox 617-739-0202 info@world.std.com	Usenet News No extra charge for 14.4 via direct dial & 96K via Compuserve Packet Network. One hr. free demo trail available.	No setup fee. Fasic Rate: $5/mo. Or 20/20 Plan: $20/mo. 0PC-Pursuit: $3 setup fee.	a) Basic Rate: $2/hr. or 20/20: 1st $20/hr/mo. free, then $1/hr. b) Basic Rate: 1/MB/mo free, then $2/MB/mo or 20/20: 5MB/mo/free, then $2/MB/mo.	No 800# service available. Pay telco for calls to 617 or add $5.60/hr. for compuserve Packet Ntwk. or $30/30hr/mo. for PC-Pursuit (2400 baud max.) during off peak (M-Th 6pm-7am, F 6pm-M 7am).	Customer support available by Email and phone M-F 6am-8pm, S-S 6am-10pm PST. Printed and online tutorial available. simple mailers available.

Beyond Dialup

The "Dialup" chart presents information about straightforward "simple" (asynchronous) dialup, the 'lowest common denominator' method of connection: dialup at any old speed with any old sort of modem with any old sort of microcomputer. Such a method is well suited to an individual using a microcomputer that is not permanently connected to some sort of in-house network or other larger computer.

Other, more complex, computer or workplace environments are often better served by different connection methods. These methods are considerably more complex to establish and maintain than simple dialup. Suppliers often take the responsibility for establishing such connections because of their technical complexity.

Users of high-speed modems might wish to implement SLIP or PPP connections, particularly if many large file transfers are being contemplated.

Users with mail service on Local Area Networks (cc:mail or QuickMail, e.g.) might want gateways between their local mail service and Internet mail. Users of Unix machines may wish to establish UUCP mail service; PC and Mac users can also obtain UUCP look-alike software to run on their machines.

Institutions making heavy use of the Internet might wish to have their Internet supplier reserve a phone number for their exclusive use or might wish a dedicated, leased line running at 9.6, 14.4, 56, 256, or 1,544 (T1) Kb. A variety of analog and digital circuits are supported by the various suppliers.

The following chart exhibits the service offerings of companies serving California. No attempt has to been made to comprehensively indicate pricing, for several reasons. First, the monthly circuit cost can be a very substantial portion of the overall cost. Circuit costs of leased lines are distance-sensitive. Second, the offerings of the various suppliers often are not exactly comparable; one supplier's monthly charge may include rental of a router, modem, and CSU/DSU while another supplier assumes the customer will supply these items. One supplier may provide dialup service nationally as an adjunct to the leased line service, another may not. Variable, as well, are the assistance and responsibility the various suppliers will take for installing the service, whether training is offered, whether fees are to be paid monthly or annually, etc.

To give some idea of charges involved, the following may be helpful:

CERFnet, for example, offers leased line service at 14.4, 56, and 1,544 Kb; setup fees for these services are $1,500, $2,500, and $3,750 respectively while monthly fees are $700, $1,300 and $1,675 respectively; these fees include installation and rental of the requisite equipment but not the monthly circuit cost.

PSI's CCS service, with no setup fees, offers 19.2, 56, and 1,544 Kb service annually for $10,500, $19,500, and $49,000 plus monthly circuit costs; equipment at the library's end is supplied by the library. 56Kb Frame Relay service is offered at $650 per month plus a setup fee of $600.

ISI Network Associates has a setup fee of $2,000 for 56KB, $4,000 for T1 service. Both services have an annual fee of $5,000. The library pays for circuit costs and equipment at its end.

UUNet/Alternet has a setup fee of $2,000 for either 19.2 or 56 Kb service, $5,000 for T1. Monthly charges, in order of increasing speed, are $500, $1,000, and $2,000. To these fees must be added the cost of the circuit and equipment at the library's end.

In the cells below, L stands for leased line, D for dialup. Blank cells indicate uncertainty about a supplier's offering.

The column marked "Lan & Router Connections" indicates the suppliers' ability or willingness to attach to such a connection, not necessarily that they will aid, assist, or accomplish its establishment. The column marked "Consult and Install Services" reflects suppliers' willingness and readiness, as determined from their literature, to advise their customers on what equipment to obtain, to install and configure the equipment, to establish domain names, to order phone circuits, and the like. It was often difficult to determine how much assistance the various suppliers are willing to afford and whether consulting is strictly limited to advising, e.g., which brand and model router you should buy. Sometimes consulting and installation are part of the setup price, sometimes they are additional services. Note that BARRnet offers a broad range of data communications consulting services, extending well beyond Internet connectivity.

High-Speed & Leased Line Internet Access Providers

Supplier	Lan & Router Support	UUCP	SLIP or PPP	9.6	14.4	56	256	T1	Other Speeds	Consult (C) &/or Install (I) Services	Connection Points L=Leased D=Dialup
Alternet UUnet Technologies Inc. 3110 Fairview Park Dr. # 570 Falls Church, VA 22042 1-(800)-488-6385 info@uunet.uu.net	Yes	Yes	Yes	L & (using SLIP or PPP) D	L & (using SLIP or PPP) D	L	No	L	19.2Kbs L Low duty cycle T1	C	Berkeley, LAngeles, PAlto, SDiego, SJose
BARRnet Pine Hall #115 Stanford, CA 94305 1-(415)-725-1790 baer@jessica.stanford.edu	Yes	No	Yes	L & D (using SLIP or PPP)	L & D (using SLIP or PPP)	L	No	L	Various to >10Mbs	C & I	L & D in Berkeley, PAlto, Sacramento, SFrancisco, SClara; L only in Cupertino, Davis, Monterey, SCruz
CERFnet Box 85608 San Diego, CA 92186 1-(800)-876-2373 help@cerf.net	Yes	Yes	Yes	D using SLIP	L using PPP D using SLIP	L	No	L	SMDS	C & I	L & D in PAlto, Irvine, LAngeles, Oakland, Pasadena, SDiego, SJose L only in Riverside &SBarbra
CRL Box 85608 San Diego, CA 94977 Vox 415-381-2800 Larkspur, CA 94977 info@crl.com	Yes	Yes	Yes	L & D (using SLIP or PPP	L & D (using SLIP or PPP	L	L	L		C & I	L & D in 404, 415,510, 602, 707
CSUnet California State University Information Resources and Technolgy 4665 Lampson Ave. Los Alamitos, CA 90720 (310) 985-9669 (Fax)(310) 985-9400 chris@csu.net	Yes	No	Yes	D	D	L	No	L	Frame Relay	C & I	Statewide, T1 hub in each lata. Frame Relay (public) distance insensitive.
CTSNet CTS Network Services 1274 Vistal Del Monte Dr. El Cajon, CA 92020 1-(619-953-9597 info@crash.cts.com	Yes	Yes	Yes	D using SLIP or PPP	L & Dusing SLIP or PPP	L	No	No	19.2 & 38.4Kbs L	C & I	San Diego County

Supplier	Lan & Router Support	UUCP	SLIP or PPP	9.6	14.4	56	256	T1	Other Speeds	Consult (C) &/or Install (I) Services	Connection Points L=Leased D=Dialup
ISI Network Associates Information Sciences Institute 4676 Admiralty Way Marina del Rey, CA 90292 1-(310)-822-1511 ina-info@isi.edu	Yes	No	No	L	No	L	No	L	64Kbs L	I	213, 310, 714, 818, 909
Netcom Netcom Online Communications Services 4000 Moorpark Ave # 209 San Jose, CA 95117 1-(408)-554-8649 info@netcom.com	Yes	Yes	Yes	L & D	L & D	L	No	L	19.2 & 38.4 Kbs L; 14.4, 56Kbs, T1 Frame Relay.		202, 206, 213, 214, 310, 404, 408, 415, 503, 510, 617, 619, 714, 818, 916
Portal Communications Co. 20863 Stevens Creek Blvd. #200 Cupertino, CA 95014 1-(408)-973-9111 info@portal.com	No	Yes	Yes	L & D	L & D	No	No	No	19.2 & 38.4 Kbs L	C & I	MtnView, SClara, Sunnyvale, SJose
PSI Performance Systems International 11800 Sunrise Valley Dr #1100 Reston, VA 22091 1-(800)-827-7482 info@psi.com	Yes	Yes	Yes	L & D	L & D	L	No	L	19.2, 500, 3,000 Kbs; 56Kbs Frame Relay	C & I	LAngeles, MtnView, SFrancisco, SClara, Sunnyvale, Portland OR
SprintLink Sprint International 13221 Woodland Park Dr. Herndon, VA 22071 1-(703)-904-2156 mkiser@icm1.icp.net	Yes	No	No	L	No	L	L	L	19.2, 128, 384, 512, 640 (All L)	C & I	35 sites thruout CA.

D

K–12 Networking Resources

The information contained in this Appendix was extracted from *The Eric Review*, Vol. 2, Issue 3, Winter 1993 and is in the public domain. In order to present the most current information, this appendix has been updated and added to. This appendix may be reproduced and disseminated freely. (References to commercial services or products contained in this publication are for information purposes only and are not to be construed as an endorsement by the U.S. Department of Education or the California Department of Education.)

To get a free copy of *The ERIC Review*, call 1-800-LET-ERIC.

Contents:

- K–12 Computer Networking Resource List
- K–12 Computer Networking Reading List

K–12 Computer Networking Resource List

Prepared by Nancy Preston, Assistant Director of the ERIC Clearinghouse for Information Resources, Syracuse University, Huntington Hall, Room 030, Syracuse, NY 13244-2340; (315) 443-3640. Please mail or email (npreston@suvm.acs.syr.edu) Nancy if you have any additions to this list.

Academy One

Affiliated with the National Public Telecomputing Network (NPTN) and the Cleveland Free-Net, this program aims to create a "national online information cooperative for K–12 telecomputing activities." Academy One allows schools throughout the world to access the resources of its community computer systems and participate in a variety of online projects and events. Participants contribute services, features, and programs to the network for others to use. Academy One publishes a free newsletter during the school year. Internet access to Academy One is offered through the Cleveland Free-Net: Telnet FREENET-IN-A.CWRU.EDU, FREENET-IN- B.CWRU.EDU, or FREENET-IN-C.CWRU.EDU. 6330 Lincoln Avenue, Suite 117, Cypress, CA 90630; (714) 821-4472. Program contact: Linda Delzeit, NPTN Director of Education. Internet: AA002@NPTN.ORG. (For information about NPTN, contact T.M. Grudner, President, Box 1987, Cleveland, OH 44106; (216) 368-2733; Internet: TMG@NPTN.ORG.)

AppleLink

This official online information resource of the Apple Computer community offers a K–12 Education Area, with special information for classroom teachers and computer coordinators. Menu selections include reviews of Macintosh education software; a discussion forum for dialogues and news; listings of conferences and other events for K–12 educators; news about education-related Apple products; and other resources, including grant opportunities, lesson plans, and research results. Access to the K–12 Education Area is through general AppleLink membership, which now includes more than 40,000 Macintosh users worldwide. Information is avail-

able from Apple sales representatives. Program contact: Lisa Bauer, Mail Stop 41-D, Apple Computer, Inc., 20525 Mariani Avenue, Cupertino, CA 95014; (408) 996-1010.

AT&T Learning Network

This curriculum-based telecommunications program for grades K–12 matches students and teachers in "learning circles" with 8 to 10 other classes around the world. The program reinforces collaborative learning through a structured, committed partnership between all matched classes. P.O. Box 6391, Parsippany, NJ 07054; 1-800-367-7225. Program contact: Joan Fenwick.

CA. ACCESS. NET

In operation since 1981, this information network offers educators and administrators email, bulletin boards, conferencing, and databases that address various topics in special education. Sponsored by the National Association of State Directors of Special Education, it includes a variety of bulletin boards maintained by editors with expertise in the fields covered, including learning disabilities, parent involvement programs, and special education litigation. For subscription information, contact GTE Education Services, GTE Place, West Airfield Drive, PO Box 619810, Dallas/Fort Worth Airport, TX 75261-9810; 1-800-927-3000.

California Online Resources for Education (CORE)

CORE is a collaborative partnership between the Department of Education and the Chancellor's Office, California State University. CORE provides K–12 educators with access to electronic information resources through direct-line connections and 150 dial-up ports installed at the 20 CSU campuses in the state. CORE offers email, bulletin board/gopher services, and databases and access to Internet resources, NETNews, and extensive California educational conferences. GINA, a new graphical interface originally developed under the leadership of the CTP project and currently managed by the CSU Institute, will soon be available at very low cost to California K–12 CORE subscribers. GINA combines several popular Internet software tools in an easy-to-use interface. This communications tool will minimize the complications of accessing remote Internet hosts, such as transferring documents and files to and from users. GINA will have both Macintosh and Windows versions available and can be installed in a regional or local file server network as well as utilized on individual microcomputers connecting to a host system that has the GINA software installed. Program contact: John Miller, CSU Chancellor's Office, (310) 985-9631; FAX: (310) 985-9400; email: gina@eis.calstate.edu.

California Technology Project

This is a multifaceted partnership project involving the Department of Education and 10 regional affiliates (located in county offices of education), which organize training, technical support, and information services for California teachers and administrators. CTP also manages the Telemation Project, a telecommunications-based curriculum development and training effort involving 18 regional partners. In phase 1, the 18 state telementors will conduct week-long institutes for a total of 432 teachers paired with local administrators. The institutes will be presented using the new Tele-learning Mobile Unit (TMU), a mobile lab with 24 workstations, each having access to Internet resources. Program contacts: Keith Vogt, CTP Director (kvogt@ctp.org), and Christina Doyle, Telemation Director (cdoyle@ctp.org), Orange County Office of Education, 200 Kalmus Drive, Costa Mesa, CA 92628; (714) 966-4268; FAX: (714) 434-0231.

Center for Children and Technology

This research center also serves as the National Center for Technology in Education, a project of the Office of Educational Research and improvement, U.S. Department of Education. The center investigates the roles of technology in children's lives—both in the classroom and in general—and the design and development of prototypical software that supports engaged, active learning. It offers a free quarterly newsletter and low-cost publications. Bank Street College of Education, 610 West 112th Street, New York, NY 10025; (212) 875-4560. Program contact: Margaret Honey. AppleLink: CTE.BCS. Internet: MHONEY@PRIME.BNKST.EDU.

Consortium for School Networking (CoSN)

CoSN is a community of organizations, government agencies, corporations, and individuals with an interest in K–12 education. Through computer networking, CoSN helps educators and students access information and communications resources that will increase their productivity, professional competence, and opportunities for learning and collaborative work. P.O. Box 65193, Washington, DC 20035-5193; (202) 466-6296. Internet: COSN@BITNIC.BITNET. Program contact: Connie Stout.

The EDUCOM K–12 Networking Project

This project aims to link practitioners in primary and secondary education through computer-mediated communication networks, and, with this connectivity, to develop networked resources to support curriculum reform and institutional restructuring. Current and planned activities include developing directories of K–12 people and resources and a user orientation packet, including primers and guides to training resources; seeking avenues for business and industry collaboration; and conducting outreach to key practitioners and policymakers. EDUCOM, 1112 16th Street NW, Suite 600, Washington, DC 20036; (202) 872-4200. Program contact: John Clement. AppleLink: EDUCOM. Internet: CLEMENT@EDUCOM.EDU.

Electronic Frontier Foundation (EFF)

This membership organization focuses on policy issues related to national networking. In the K–12 context, EFF concerns itself with policies for determining the resources to which students will have access. EFF publishes a free newsletter, EFFector Online, on general Internet topics. 666 Pennsylvania Avenue SE, Washington, DC 20003;(202) 544-9237. Internet: EFF@EFF.ORG.

ERIC Clearinghouse on Information Resources (ERIC/IR)

ERIC/IR is one of 16 clearinghouses in the ERIC System, which is sponsored by the Office of Educational Research and Improvement, U.S. Department of Education. ERIC/IR specializes in educational technology and library/information science and processes documents in these areas for the ERIC database. The clearinghouse also provides user services and publications related to its scope areas, including the ERIC Networker, electronic "help sheets" for using ERIC resources on the Internet. 030 Huntington Hall, Syracuse University, Syracuse, NY 13244-2340; (315) 443-3640. Internet: ERIC@SUVM.ACS.SYR.EDU. Program contact: Nancy Preston.

Florida Information Resource Network (FIRN)

More than 3,000 teachers and administrators in Florida have set up free accounts for email on FIRN. FIRN users also can access the ERIC database and library card catalogs of several colleges and universities in Florida through the network. To aid teachers in instructional planning, FIRN posts curriculum guides for using resources such as CNN, Newsweek, and the Discovery

Channel in the classroom. Florida Education Center, Room B1-14, 325 West Gaines Street, Tallahassee, FL 32399; (904) 487-0911.

The FrEdMail Network

This cooperative consortium maintains a distributed and low-cost telecommunications network for public agencies, such as schools, libraries, cities, and community service organizations. FrEdMail is dedicated to K–12 education, helping teachers and students participate in a wide variety of learning experiences and exchange information freely and simply. FrEdMail features learning projects that motivate students to become better learner and writers. It also lets teachers share experiences, ideas, and materials as well as information for professional development, and provides a gateway to the Internet. FrEdMail publishes a quarterly newsletter and guides to help teachers implement telecomputing. FrEdMail Foundation, P.O. Box 243, Bonita, CA 91908; (619) 475-4852. Program contact: Al Rogers. Internet: AROGERS@BONITA.CERF.FRED.ORG.

IBM/National Education Association (NEA) School Renewal Network

Dedicated to school reform, this electronic network is intended to create a research base by a community of actively engaged practitioners and researchers. Participants include partners in the center's programs, federally funded research and development laboratories and centers, several research universities, and schools from other national school reform efforts. NEA National Center for Innovation, 1201 16th Street NW, Washington, DC 20036; (202) 822-7783. Program contact: Shari Castle.

International Society for Technology in Education (ISTE), Special Interest Group for Telecommunications (SIG/Tel).

The largest international nonprofit professional organization serving computer-using educators, ISTE is dedicated to the improvement of education through the use and integration of technology. ISTE-Net, an online computer network for ISTE members, is available through GTE Education Services (1-800-927-3000). The Special Interest Group for Telecommunications publishes a newsletter about telecommunications in education, T.I.E. News. 1787 Agate Street, Eugene, OR 97403-1923; (503) 346-4414. Internet: ISTE@UOREGON.EDU. Program contact for SIG/Tel: Lynne Schrum. Internet: SCHRUMLM@SPLAVA.CC.PLATTSBURGH.EDU.

K12NET

This network is a system of more than 250 linked bulletin boards carrying thousands of messages each week among sites around the world. Participants access many subject-specific conferences and also collaborate on projects. Developed as a grassroots project, K12Net is a collaborative effort available free to anyone who can access it through a bulletin board. For more information, contact Janet Murray, 1151 SW Vermont Street, Portland, OR 97219; (503) 280-5280. Internet: JMURRAY@PSG.COM.

KIDSNET

KIDSNET is a global Internet electronic discussion group for children and their teachers. Ongoing discussions deal with general questions about computer networks and user interfaces and specific projects linking groups of children in one school or another. A spinoff of the KIDSNET list is another list called KIDS, which allows children to post messages to other children. To subscribe, send an email request to

JOINKIDS@VMS.PITT.EDU. Program contact: Bob Carlitz. Internet: CARLITZ@VMS.CIS.PITT.EDU.

Learning Link National Consortium

Learning Link is a computer-based, interactive communication system for K–12 educators, students, adult learners, and public television viewers. It features databases and information resources, message centers, and mail and gateways to remote sites. Its services are locally managed and operated by public broadcasting stations, education agencies, or community organizations in 13 states. A national version is available to those who do not have access to the local version. The national consortium provides technical support and editorial content; site operators tailor the services to meet community needs. WNET/13, 356 West 58th Street, New York, NY 10019; (212) 560-6613.

Merit/NSF Information Services

Merit Network, Inc., which operates the NSFNet backbone, also provides information support services to the networking community through email or telephone. Staff offer help in using the Internet and information about K–12, which can be requested through email to NSFNET-LINKLETTER-REQUEST@MERIT.EDU. To obtain hard copies, write to the organization. Merit Network, Inc., 2901 Hubbard, Pod G, Ann Arbor, MI 48105-2016; 1-800-66-MERIT or (313) 936-3000. Internet: NSFNET-INFO@MERIT.EDU.

National Geographic Kids Network

Kids Network is an international telecommunications-based science and geography curriculum for fourth- through sixth-graders created by the National Geographic Society and Technical Education Research Centers, Inc. Students at schools in 50 states and more than 20 countries are assigned to research teams composed of 10 to 15 different classes. They investigate topics such as the water supply, weather, pollution, nutrition, and solar energy on the local level, then compare data with other membersof their research team. Scientists help them trace geographic patterns in the data through letters, maps, and graphs. A Spanish-language version of the curriculum is being piloted. For prices and session dates, contact National Geographic Society, Educational Services, Washington, DC 20036; 1-800-368-2728.

National Science Foundation's Network Service Center (NNSC)

The mission of NNSC is to collect, maintain, and distribute information about NSFNet and provide assistance to networking end users. NNSC maintains the Internet Resource Guide, which is available through anonymous file transfer protocol at NNSC.NSF.NET, directory resource guide. This and other resources can also be obtained by sending email to INFO-SERVER@NNSC.NSF.NET, and typing in the body of the message:

Request: info

Topic: help

NNSC also offers network assistance through email and a telephone hotline. 10 Moulton Street, Cambridge, MA 02138; Hotline: (617) 873-3400. Internet help: NNSC@ NNSC.nsf.net. Program contact: Corinne Carroll.

New York State Education and Research Network (NYSERNet)

NYSERNet is a regional network of the National Science Foundation's NSFNet and the Internet. NYSERNet links more than 70 state institutions of higher education, industries, government agencies, libraries, and schools to each other and to the Internet. It includes a K–12 networking interest group. 111 College Place, Syracuse, NY 13244-4100; (315) 443-4120. Internet: INFO@NYSERNET.ORG.

Northwest Regional Educational Laboratory (NWREL)

A program of the Office of Educational Research and Improvement, U.S. Department of Education, NWREL seeks to improve schools and classroom instruction in the states of the northwest. NWREL has a special interest in education technology and networking and offers publications and a free newsletter, the *Northwest Report*, to a national audience. 101 Southwest Main Street, Suite 500, Portland, OR 97204; (503) 275-9500. Program contact: Jerry Kirkpatrick.

SENDIT

SENDIT is a pilot K–12 computer network for North Dakota educators and students developed by the North Dakota State University (NDSU) School of Education and Computer Center. Currently, the host NeXT computer may be accessed through six toll-free and four local numbers in North Dakota. More than 70 forums have been established for topical discussions; educators also have limited access to the Internet. Box 5164, NDSU Computer Center, Fargo, ND 58105; (701) 237-8109. Program Contact: Gleason Sackman. Internet: SACKMAN@PLAINS.NODAK.EDU.

SouthEastern Regional Vision for Education (SERVE)

A program of the Office of Educational Research and Improvement, U.S. Department of Education, SERVE focuses on improving education in the southeastern region of the country. SERVE-Line is an online information system offering educators news and product announcements, instructional software that can be downloaded ("shareware"), discussion groups, and email. Users may also request a free ERIC search; results will be uploaded to the network in approximately 2 weeks. Nonmembers with telecommunications software and a modem can get limited access to SERVE-Line through 1-800-487-7605. For more information or a membership, contact SERVE, 41 Marietta Street NW, Suite 1000, Atlanta, GA 30303; 1-800-659-3204.

Technical Education Research Centers (TERC)

This program researches, develops, and disseminates innovative programs for educators. A special interest is curriculum projects involving tele-computing. Services include outreach, technical assistance, curriculum guides, and information dissemination. TERC also publishes a free newsletter, *Hands On!* 2067 Massachusetts Avenue, Cambridge, MA 02140; (617) 547-0430. Program contact: Ken Mayer. Internet: KEN_MAYER@TERC.EDU.

Texas Education Network (TENET)

TENET currently links more than 12,000 K–12 educators and administrators who use the network for email, resource sharing, and access to databases via the Internet. Among the offerings made available to TENET users are news services, reference materials, and full-text ERIC digests. As TENET expands, users will be able to access the Internet through a local call to 1 of 16 sites across the state or through a toll-free number. Texas Education Agency, 1701 North Congress Avenue, Austin, TX 78701; (512) 463-9091.

Virginia's Pen

Approximately 6,000 educators currently have accounts on Virginia's statewide network. They can access Virginia's Pen via a local call to one of several sites across the state or through a toll-free line if they are located in a remote area. Network offerings include various discussion groups, topical news reports, study skills guides, and curriculum resources. Through History Online, students and teachers can pose

questions to designated historians who will respond in the character of key historical figures, including Thomas Jefferson and James Madison. Virginia Department of Education, 101 North 14th Street, 22nd Floor, Richmond, VA 23219. Program contact: Harold Cathern. Internet: HCATHERN@VDOE386.VAK12ED.EDU.

Gopher Servers with Extensive K–12 Documents

ERIC (Educational Resources Information Center) provides searchable online full-text documents and pointers to K–12 information; the AskERIC service does free custom searches. Questions covered: K–12 education, learning, teaching, information technology, educational administration. Point gopher client (command 'o') to: ericir.syr.edu Port=70.

Education Gopher at Florida Tech. Point your gopher client (command 'o') to: sci-ed.fit.edu Port=70.

Documents organized by Discipline: Point your gopher client (command 'o') to: jarrah.itd.adelaide.edu.au. Follow menu path: Menu of variousservers and sites/SUBJECTS/Encyclopedia-style subject menus (compiled at ITD)/ Resources by subject—Alphabetical.

Note on Finding Online Documents

Items identified as RFCs are Requests For Comments, Internet documents which either set forth standards or provide useful information on various topics related to the Internet and its protocols. Instructions for accessing these and most other online documents via Gopher are included in each item. You must be running a gopher client on your Internet-connected machine (or must be able to telnet to a public gopher client (e.g., gopher.msu.edu) if you are connected via dial-up [through a modem]). Two access methods are used. When directed to "point your gopher," press 'o' ("oh" not zero) and then type the address given. Then use the following menu entries to find the document. Note that sites sometimes change menus, in which case it may be necessary to browse to find the document. When directed to "Access via Veronica keyword search", select the 'Veronica' or 'Search Gopherspace' or similar entry on whichever gopher server to which your client has connected you, and, when instructed to enter a keyword, type the word(s) given in the item.

K–12 Computer Networking Reading List

This list was compiled from many sources, including the ERIC Clearinghouse for Information Resources, Syracuse University.

Aboba, Bernard. *The Online User's Encyclopedia: Bulletin Boards and Beyond*. Reading, MA: Addison-Wesley, 1994. 806 pp. ISBN 0-201-62214-9, US$32.95. A remarkably useful and comprehensive work covering everything from the basics of computer communications to using local bulletin boards to the intricacies of the Internet.

Anderson, R. E. (Ed.) (1993). *Computers in American Schools, 1992: An Overview* (National Science Foundation Grant No. SED-09154511). Minneapolis, MN: University of Minnesota, International Association for the Evaluation of Educational Achievement.

Becker, Henry J. "Teaching With and About Computers in Secondary Schools," *Communications of the ACM*, May 1993, V.36, pp. 69-73.

Bowers, K. L. et al. "FYI on Where to Start: A Bibliography of Internetworking Information" (RFC 1175), 1990. Point your gopher client (command 'o') to: rock.concert.net Port=70.

Braun, L. "Help for All the Students," *Communications of the ACM*, May 1993, V.36, pp. 66-69.

Cerf, Vinton G., Testomony before US House of Representatives, Committee on Science, Space, and Technology, Subcommittee on Technology, Environment, and Aviation, March 23, 1993. Access via Veronica Keyword Search: 'nii.cerf'.

Computers and Opportunities for Literacy Development. Jo Anne Kleifgen, 1989.

This ERIC Digest (#EDO-UR-89-4) cites several examples of ways that email has been used to support literacy and English as second-language programs. Free with self-addressed stamped envelope (SASE). ERIC Clearinghouse on Urban Education, Institute for Urban and Minority Education, Box 40, Teachers College, Columbia University, New York, NY 10027; (212) 678-3433. Internet: LRY2@CUNIXF.CC.COLUMBIA.EDU.

Connecting to the Internet: An O'Reilly Buyer's Guide. Susan Estrada, 1993. This book is an excellent resource for those getting a connection into the Internet. It is designed to assist as well as inform. After reading *Connecting to the Internet*, you will be prepared to converse with an Internet service provider as well as independently assess your needs and decide what is right for you. The book describes the different types of Internet connections and helps you evaluate usage, speed, equipment, service, and price as the key factors. $15.95. O'Reilly & Associates, Inc., 103 Morris Street, Suite A, Sebastopol, CA 95472; 7AM - 5PM PST, 1-800-998-9938. Or email: order@ora.com.

"The Consortium for School Networking Mailist: CoSNDISC", To subscribe, send email message: 'subscribe cosndisc <your first and last name>', to: listproc@cren.org

Cook, Gordon, *What Should We Plan Given the Delemma of the Network?* (RFC 1527), 1993. Point your gopher client (command 'o') to: rock.concert.net Port=70.

Crossing the Internet Threshold. Roy Tennant, John Oper, and Anne G. Lipow, 1993. This instructional handbook, written by librarians, is designed to be used for learning and for further training. Provides both beginners' information and trainers' aid to all basic Internet functions. $45. Library Solutions Institute, 2137 Oregon Street, Berkeley, CA 94705. For information, send email to: ALIPOW@LIBRARY.BERKELEY.EDU.

December, John, *Information Sources: the Internet and Computer-Mediated Communication*. An extensive, though compact, regularly updated list of sources of information describing the Internet, computer networks, training documents, and issues related to computer-mediated communication (CMC). Point your gopher client (command 'o') to: csd4.csd.uwm.edu inet.services.txt. Follow menu path: Remote Information Server/Internet Information Source Index. Available by anonymous FTP from ftp.kpi.edu, directory/pub/communications, file name internet.cmc.txt.

Directory of Electronic Journals, Newsletters and Academic Discussion Lists, Second Edition, Michael Strangelove and Diane Kovacs, 1992 This complete directory describes electronic discussion groups and provides instructions for subscribing. Contents are arranged by subject. $25. Association Research Libraries, Office of Scientific and Academic Publishing, 1527 New Hampshire Avenue NW, Washington, DC 20036. Electronic copies can be obtained by sending email to: LISTERV@KENTVM.BITNET. In the body of the message, type: GET ACADLIST FILE1; GET ACADLIST FILE2; GET ACADLIST FILE3; GET ACADLIST FILE4; GET ACADLIST FILE5; GET ACADLIST FILE6.

Documents Organized by Discipline. Point your gopher client (command 'o') to: jarrah.itd.adelaide.edu.au. Follow menu path: Menu of various servers and sites/SUBJECTS/Encyclopedia-style subject menus (compiled at ITD)/ Resources by subject—Alphabetical.

Ednet Educators Guide to E-mail List. A list of mailists (with one-line descriptions and arranged by discipline) for educators at all levels with instructions for subscribing. Access via Veronica Keyword Search: 'ednet

"Education Gopher at Florida Tech." Point your gopher client (command 'o') to: sci-ed.fit.edu Port=70.

*Electronic Frontier Foundation, Big Dummy's Guide to the Internet, big-dummys-guide.*txt, 1993. Access via Veronica Keyword Search: 'dummy'.

ERIC (Educational Resources Information Center) provides searchable online full-test documents and pointers to K–12 information. The AskERIC service does free custom searches. Questions covered: K–12 education, learning, teaching, information technology, educational administration. Point gopher client (command 'o') to: ericir.syr.edu Port=70.

Exploring the Internet: A Technical Travelogue by Carl Malamud. Prentice-Hall Publishers. (515) 284-6751. FYI on Questions and Answers to Commonly Asked "New Internet User" Questions: Request for Comments 1325.

Gary Scott Malkin and April N. Marine, 1992. This working memo provides complete answers to the most common questions about the Internet, including many technical subjects. Includes a lengthy glossary. Electronic copies available through anonymous file transfer protocol (FTP) at host ftp.nisc.sri.com, directory rfc, filename rfc1325.txt. User Services Working Group, Network Information Systems Center, SRI International, Room EJ291, 333 Ravenswood Avenue, Menlo Park, CA 94025; (415) 859-3695.

Gilster, Paul *The Internet Navigator.* New York: John Wiley, 1993. 470 pages. ISBN 0-471-59782-1, US$24.95. (An elegantly written and cleanly designed guide-book, the best of the new books for the individual dial-up user. Contains a wealth of useful background information on the workings of the Internet and the organizations behind it. Recommended for the individual dial-up user who is serious about the Internet.)

Hahn, Harley and Rick Stout. *The Internet Complete Reference.* Berkeley: Osborne McGraw-Hill, 1993. 818 pages. ISBN 0-07-881980-6, US$29.95. Considered by many the best of the new crop of Internet books and at 800+ pages among the most comprehensive. The humor, however, seems somewhat more lame than some others.

Harris, Judi B. *Way of the Ferret.* International Society for Technology in Education, 1994. ISBN: 1-56484-055-7. 8 1/2 x 11, 191 pages. Cost: $24.94 (members $22.95). To order: 1-800-336-5191.

Hawkins, Jan, "Technology and the Organization of Schooling," *Communications of the ACM,* May 1993, V. 36, pp 30-35.

Hoffman, E., and L. Jackson, *FYI on Introducing the Internet—A Short Bibliography of Introductory Internetworking Readings for the Network Novice* (RFC 1463), 1993. Point your gopher client (command 'o') to: rock.concert.net Port=70.

Honey, M. & Henriquez, *A., Telecommunications and K–12 educators: Findings from a national survey.* New York: Bank Street College of Education, Center for Technology in Education, 1993.

Hunter, B. "Linking for Learning: Computer and Communications Network Support for Nationwide Innovation in Education," *Journal of Science Education and Technology,* 1, (1), 23-34, 1992.

Internet Basics, Roy Tennant, 1992. This ERIC Digest (#EDO-IR-92-7) introduces the Internet computer network and provides an overview of the applications and resources the network provides. Specific topics include electronic mail, remote login (telnet), file transfer, and extended services, such as WAIS, Gopher, and Archie. Free with SASE. ERIC Clearinghouse on Information Resources, 030 Huntington Hall, Syracuse University Syracuse, NY 13244-2340; (315) 443-3640. Internet: ERIC@SUVM.ACS.SYR.EDU.

The Internet Companion: A Beginner's Guide to Global Networking by Tracy LaQuey with Jeanne C. Ryer (Addison-Wesley Publishing). The companion includes a detailed history of the Internet, a discussion on "netiquette" (network etiquette), and how to find resources on the net. Useful for the computer-literate Internet novice. ISBN: 0-201-62224-6. 1993. $10.95.

The Internet Connection: System Connectivity and Configuration by John S. Quarterman and Smoot Carl-Mitchell. ISBN 0-201-54237-4, 1994. Published by Addison-Wesley Publishing Co. <awbook@aw.com>. This reference guide explains how to become a part of a community where global communication, resource discovery, and resource sharing are brought to your desktop through the Internet. This book serves as the central source of information about the Internet from technology questions to administrative questions.

Internet: Getting Started. Authors: Marine, Kirkpatrick, Neou, Ward. SRI Internet Information Services, PTR Prentice Hall. Published by PTR Prentice Hall, New Jersey. Explains how to join the Internet, the various types of Internet access, and procedures for obtaining a unique IP address and domain name. An extensive list of Internet access providers of all types is provided, including access outside of the United States. The guide explains many concepts essential to the Internet, such as the Domain Name System, IP addressing, protocols, and electronic mail. ISBN: 0-13-327933-2. 1993. Paperback, 360 pages. $28.00.

The Internet Guide for New Users, by Daniel P. Dern. A very complete introduction to the world of the Internet. Along with the obligatory topics, such as telnet, FTP and Archie, the book suggests how to get an Internet account and teaches enough UNIX to survive on the net. McGraw-Hill, Oct. 1993. 570 pages. Paperback $27.95 ISBN: 0-07-016511-4. Hardcover $40.00: ISBN# 0-07-016510-6.

Internet: Mailing Lists 1993 Edition. Franklin F. Kuo, Series Editor. SRI Internet Information Services. Published by PTR Prentice Hall, New Jersey. ISBN: 0-13-327941-3. Copyright 1993. Paperback, 356 pages. (Note that a current "list of lists" is also available online, both via Usenet and FTP. See the final section.)

The Internet Passport: NorthWestNet's Guide to Our World Online, 4th ed. This is published by NorthWestNet and the Northwest Academic Computing Consortium, Inc. It is 516 pages and covers everything from net etiquette to supercomputers; very comprehensive. It costs $39.95, but schools and not-for-profit organizations can buy it for $19.95 plus shipping. NorthWestNet, 15400 SE 30th Place, Suite 202, Bellevue, WA 98007. (206) 562-3000. email for info: "passport@nwnet.net".

Internet Primer for Information Professionals: A Basic Guide to Internet Networking Technology. By Elizabeth Lang and Craig Summerhill, Meckler Publishing. ISBN: 0-88736-831-X. 1993. $37.50.

Internet Resource Guide. NSF Network Service Center (NNSC), 1989–This directory of Internet-accessible resources includes computational re-

sources, network information centers, library catalogs, archives, and more. $25 prepaid (note "4001-49-06480" on check). Bolt, Beranek and Newman, 10 Moulton Street, Mail Stop 6/3B, Cambridge, MA 02138; (617) 873-3400. Electronic copies are available through anonymous FTP from host nnsc.nsf.net, directory resource-guide. Updates are available continuously. For more information, send email to NNSC@NNSC.NSF.NET.

The Internet Starter Kit for the Macintosh by Adam Engst, ISBN 1-56830-064-6. Published by Hayden Books. This terrific book (with a floppy disk) gives Macintosh users the complete scoop on getting connected to the Internet, using PPP, SLIP, etc. $29.95.

Internet System Handbook. by Danial Lynch and Marshall Rose. Addison-Wesley Publishing, 1993. $54.95.

Internet-Accessible Library Catalogs and Databases. Art St. George and Ron Larsen, 1991. This state-by-state directory of library catalogs accessible through the Internet describes each resource. Also includes instructions for accessing campus-wide information systems and dial-up libraries. Electronic copies available through anonymous FTP at host ariel.unm.edu, directory library, filename internet.librar. For more information, send email to Art St. George, Executive Network Services Officer, University of New Mexico; (505) 277-8046. Internet: STGEORGE@BOOTES.UNM.EDU.

Jaffe, Lee David. *Introducing the Internet: A Trainer's Workshop*. Internet Workshop Series, Number 1. Berkeley, CA: Library Solutions Press, 1994. 92 pages. ISBN 1-882208-05-6, US$30.00 (US$45.00 with diskette). The first in a series of supplements to *Crossing the Internet Threshold*, by Tennant, Ober, and Lipow. Based on an actual trainer's handouts and scrip, it may also be used as a self-instruction workbook.

Krol, E. and E. Hoffman, "What Is the Internet?" (RFC 1462). 1993. Point your gopher client (command 'o') to: rock.concert.net Port=70.

LaQuey, Tracy. *The Internet Companion Plus: A Beginner's Startup Kit for Global Networking*. Reading, MA: Addison-Wesley, 1993. 196 pages. ISBN 0-201-62719-1, US$19.95. A good guide for the true beginner, useful even for the pre-beginner who has not yet signed on to the Internet.

Library Resources on the Internet: Strategies for Selection and Use. Laine Farley, editor, 1992. This guide gives instructions for remote access to library catalogs through telnet. Also includes information about how to locate library catalogs on the Internet, discussion of gateways and clients, and a description of typical online catalog features. $18 members, $20 others. American Library Association Publications, 50 East Huron Street, Chicago, IL 60611; 1-800-545 2433. Electronic copies are available through anonymous FTP from host dla.ucop.edu, directory pub/internet, filename libcat-guide.

Love, James, "Letter to the Editor," *The New Republic* (enumerating public policy issues relating to the National Information Infrastructure and the National Research and Education Network). File: new_republic_930524, May 18, 1993. Access via Veronica Keyword Search: 'new and republic'.

Mac Internet Tour Guide by Michael Fraase. Published by Ventana Press. ISBN 1-56604-062-0. $27.95. This book (with floppy disk) for Macintosh users helps newcomers get online and get acquainted with graphical Internet software "Fetch" and "Eudora."

Martin, J., "There's Gold in Them Thar Networks! or Searching for Treasure in All the Wrong Places." 39 p. (RFC 1402), 1993. Point your gopher client (command 'o') to: rock.concert.net Port=70.

Merit Network, Inc. *Cruise of the Internet*, Merit Network Inc., Ann Arbor, MI. (A binary tutorial program available for Macintosh or Windows), 1992.

Mining the Internet. Computing Services, University of California (U.C.) Davis, 1991. Developed for use at a conference at U.C. Davis, this guide is a friendly introduction to Internet functions and resources in a scavenger hunt format. Contains some system-specific instructions that must be worked around. Electronic copies are available through anonymous FTP at host ucdavis.edu, directory ucs.netdocs, subdirectory mining. For information, call Computing Services, U.C. Davis, (916) 752-0233.

A National Information Network: Changing Our Lives in the 21st Century. Institute for Information Studies, 1992. This book contains a collection of essays exploring the many benefits, potential disadvantages, and issues associated with developing and managing a national information infrastructure. Technological, economic, and policy aspects of such network are considered. The book is an annual review of the Institute for Information Studies, established by Northern Telecom and The Aspen Institute. $7.95. Contact the Publications Manager, Aspen Institute, Wye River House, P.O. Box 222, Queenstown, MD 21658; (410) 820-5433.

The National Research and Education Network (NREN): Promise of a New Information Environment. Ann P. Bishop, 1990. This ERIC Digest (#EDO-IR-90-4) describes the proposed legislation for NREN (as of late 1990) and the emergence of the electronic network as a general communication and research tool. Free with SASE. ERIC Clearinghouse on Information Resources, 030 Huntington Hall, Syracuse University, Syracuse, NY 13244-2340; (315) 443-3640. Internet: ERIC@SUVM.ACS.SYR.EDU.

The National Research and Education Network (NREN): Update 1991. Ann P. Bishop, 1991. This ERIC Digest (#EDO-IR-91-9) reports on federal policy initiatives related to NREN (as of late 1991) and discusses trends and issues in electronic networking they pertain to members of the education and library communities. Free with SASE ERIC Clearinghouse on Information Resources, 030 Huntington Hall, Syracuse University, Syracuse, NY 13244-2340; (315) 443-3640. Internet: ERIC@SUVM.ACS.SYR.EDU.

Navigating the Internet. Richard J. Smith and Mark Gibbs. SAMS Publishing, 1994. ISBN: 00-672-30485-6. 7 1/4 x 9, 640 pages. Cost: $29.95. The book comes with a disk of Internet programs for PC Windows and a form to get a disk of Macintosh programs for $5. The book is not very UNIX-oriented.

Networked Resources in Computers in Libraries. Gord Nickerson, September 1991. In this regular column (11 times a year), Gord Nickerson describes in detail of a particular Internet function or resource. Computers in Libraries (ISSN 1047915), Meckler Corporation, 11 Ferry Lane West, Westport, CT 06880; (203) 226–6967. For information, send email to meckler@jvnc.net.

NetTEACH News, an online newsletter for K–12 teachers, Kathy Rutkowski Editor, Herndon, VA. E-Mail: kmr@cnri.reston.va.us. Access via Veronica Keyword Search: "netteach'.

Newman, Dennis, "School Networks: Delivery or Access," *Communications of the ACM*, May 1993, V.36, pp. 49–51.

Newman, D., Bernstein, L.L., & Reese, P.A. *Local Infrastructures for School Networking: Current Models and Prospects* (Tech. Rep. No. 22). New York: Bank Street College of Education, Center for Educational Technology, 1992.

New User's Guide to Useful and Unique Resources on the Internet, Version 2.3 NYSERNet, Inc., 1992. This guide provides directions for using a variety of resources on the Internet can be accessed through FTP, telnet, or electronic mail. It includes databases, campus information systems, directories, library catalogs, FTP archives, bulletin board services, and more. $18. NYSERNet affiliates; $25 others. NYSERNet, Inc., 111 College Place, Syracuse, NY 13244-4100; (315) 443-4120. Internet: INFO@NYSERNET.ORG.

NSCA Education Group. An Incomplete Guide to the Internet and Other Telecommunications Opportunities. July 1993.

Quarterman, John. Recent Internet Books, w/brief descriptions, citations to reviews, prices, publishers w/addresses, (RFC 1432), 1993. Point your gopher client (command 'o') to: rock.concert.net Port=70. Spurgeon, Charles, "Network Reading List: TCP/IP, UNIX, and Ethernet," February, 1992. (For network managers, developers and users.) Point your gopher client (command 'o') to: nic.cerf.net Port=70. Follow menu path: General Internet Information/readings/network-reading-list.txt.

Riel, M., & Levin, J.A., "Building Electronic Communities: Success and Failure in Computer Networking," *Instructional Science*, 19, 145-169, 1990.

Sheingold, K., & Hadley, M. *Accomplished Teachers: Integrating Computers into Classroom Practice.* New York: Bank Street College of Education, Center for Educational Technology, 1990.

Smith, Richard and Mark Gibbs. *Navigating the Internet.* Carmel, Indiana: SAMS Publishing, 1993. 500 pages. ISBN 0-672-30362-0, US$24.95. A highly readable guide, with an easy-to-use listing of Internet resources arranged by subject. Smith is well known for his popular online Navigating the Internet courses.

"Surfing the Internet: An Introduction" in *Wilson Library Bulletin.* Jean Armour Polly, Vol. 66, No. 10, pp. 38-42, June 1992. This Internet introduction shows librarians how they can benefit from networkconnectivity. Basic Internet resources and activities are described. *Wilson Library Bulletin* (ISSN 0043-5651), H.W. Wilson, 950 University Avenue, Bronx, NY 10452; 1-800-367-6770.

Surfing the Internet, Volume 2. Jean Armour Polly, December 1992. This updated resource guides librarians in their explorations of the Internet. It is available through anonymous FTP at host nysernet.org, directory/pub/resource/ guides, filename surfing. the. internet.2.0.txt.

Using Electronic Mail in an Educational Setting, Fastback 316. Dan H. Wishnietsky, 1991. This brief report describes uses of electronic mail/message systems in education for many purposes: recording grades, sending memos, accessing databases, communicating among faculty, allowing cooperative research, and developing multicultural curricula. $.90. Phi Delta Kappa, P.O. Box 789, Bloomington, IN 47402-0789. Also available from the ERIC Document Reproduction Service as ED 333 865. For information, call 1-800-443-ERIC.

Using Technology to Support Education Reform, Office of Research, U.S. Department of Education, September 1993. For sale by the U.S. Government Printing Office, Superintendent of Documents, Mail Stop: SSOP, Washington, DC 20402-9328. ISBN 0-16-042048-2.

Using UUCP and Usenet by Grade Todino and Dale Dougherty. 194 pages. O'Reilly & Associates. 1991.

Welburn, E. *Information, Telecommunications, and Learning: A Review of the Research Literature.* Sidney, British Columbia, Canada: Educational Technology Centre of British Columbia, 1992.

The White House, "The National Information Infrastructure: Agenda For Action," September 15, 1993. Point your gopher client (command 'o') to: ace.esusda.gov. Follow menu path: Americans Communicating Electronically/National Information Infrastructure documents.

The Whole Internet: User's Guide and Catalog. Ed Krol, 1992. This book explains what the Internet is and how it works and describes how to find resources on the network with tools such as Archie, Gopher, WAIS, and the World-Wide Web. It includes a catalog of more than 300 resources on topics from aeronautics to zymurgy, as well as a list of Internet service providers. $24.95. O'Reilly & Associates, Inc., 103 Morris Street, Suite A, Sebastopol, CA 95472.

Yanoff, Scott, Compiler, "Special Internet Connections," (a regularly updated listing of information sources of use to educators by subject). Point your gopher client (command 'o') to: csd4.csd.uwm.edu. Follow menu path: Remote Information Server/Internet/Internet Services List.

Zen and the Art of the Internet, Second Edition. Brendan P. Kehoe, 1993. Aimed at the novice user, this book is intended to serve as a reference work and a foundation from which network users can explore the realm of Internet resources. $22. Prentice-Hall, 200 Old Tappan Road, Old Tappan, NJ 07675; 1-800-922-0579. Electronic copies of the first edition are available free through anonymous FTP at host cs.widener.edu (147.31.254.132), directory pub/zen, filename zen-1.0.tar.Z, 1.0.dvi, and zen-1.0.PS.

Acceptable Use Policies

By its very nature, the free-flowing, uncensored exchange of communication that characterizes the Internet has forced the issue of how and by whom the network should be used. Realizing the potential for everything from criminal activities to unwholesome entertainment, many network administrators are wary of the negative power of the Internet in an educational environment.

Consequently, a plethora of appropriate and acceptable-use policies have sprung up across the country in the last two years. Small rural schools (such as Woodland High School in California) as well as national organizations (such as the National Science Foundation) are addressing the issue by setting limits on the use of their networks. Depending upon its source, an acceptable-use policy may take the form of a loosely interpreted guideline or a stringent set of rules and regulations. Generally, acceptable use standards fall within the jurisdiction of a network's system administrator both in design and enforcement. Violators can expect termination of their accounts. The system administrator may be at the school, district, county office of education or an Internet service provider, although usually the policy will be designed by the local school administration in charge of school or district networks.

Although each educational institution may use language geared to its particular constituency, many acceptable use policies share common criteria. We selected fourteen samples from across the country for the purposes of this document. They represent two professional networking organizations, three state educational networks, five universities, and four high schools. The following concerns were expressed throughout all institutions:

1. Use of the network is intended to aid education and research.
2. Use of the network may not be used for personal profit or commercial activities.

Other networking issues reflected in the above samples appear below in descending order of frequency:

1. Must not display pornography or obscenities 6
2. Must not violate other users' right to privacy 6
3. Student users must sign a contract 4
4. Users must comply with etiquette rules 4
5. Institution not liable for service or damages 4
6. Must not break or suggest breaking any civil laws 4
7. No vandalism; e.g., destroying data or loading viruses 4
8. SysAdmin preselects listservs/ newsgroups 4
9. Must not restrict others' use of network 4
10. Only public domain software may be uploaded 3
11. Must conserve time and space and maintain email 3
12. Must not disseminate copyrighted material 3

13. Security problems must be reported to SysAdmin 2
14. Users must receive training and be tested 1
15. Internet sticker must be placed on students' ID cards 1
16. Game playing; e.g., MUD, not allowed 1

Requests for comments (RFC) regarding acceptable use policies appear often among the many Internet newsgroups. A carefully placed RFC can result in literally hundreds of responses from members of the queried newsgroup. Researchers should be advised of the power of this medium and proceed with caution.

Another option for accessing current acceptable use policies is to find servers that already contain archives of such information. One of the best sources available is the Armadillo server in Texas. The Armadillo server can be reached using gopher by burrowing through All the Gopher Servers in the World and scrolling down through the alphabetical listing to Armadillo, the Texas Studies Gopher. From that point, go to More About Armadillo and Other Gophers, then to Acceptable and Unacceptable Use of Net Resources (K12).

As previously mentioned, acceptable-use policies mirror the environment of their particular organizations. Since everyone's needs are different, no two policies look exactly alike. But we offer the following document from Woodside School District in Woodside, California, as an example of what one district adopted. In addition to setting standards of behavior on the Internet, it also includes a sample contract page for students, for parents or guardians (if the student is under the age of 18), and for the sponsoring teacher.

WOODSIDE SCHOOL DISTRICT
Student Network Responsibility Contract

Please read the following carefully before signing this document. This is a legally binding contract and must be signed before you will be given an access account.

BARRNet is an electronic network which accesses the Internet. The Internet is an electronic highway connecting thousands of computers all over the world and millions of individual people. Students, teachers, support staff, parents and community members with accounts on the mail.barrnet.net server have access to: 1) electronic mail (email) communication with people all over the world; 2) information and news from a variety of sources and research institutions; 3) public domain and shareware software of all types; 4) discussion groups on a wide variety of topics; 5) access to many university libraries, the Library of Congress, and more!

(With access to computers and people all over the world also comes the availability of some material that may not be considered to be of educational value within the context of the school setting. Woodside School District (WSD), James B. Flood Elementary (Flood), the Autodesk Foundation (AFdn), and all other schools involved in NET AGE have taken every available precaution to restrict access to controversial materials.

However, on a global network it is impossible to control all materials. The users of mail.barrnet.net firmly believe that the valuable information and interaction available on this worldwide network far outweigh the possibility of users procuring material that is not consistent with the educational goals within each school.

Attached are guidelines provided to establish the responsibilities you are about acquire. If any user violates any of these provisions, his or her account on mail.barrnet.net will be terminated, and all future access could possibly be denied. The signature(s) at the end of this document is (are) legally binding and indicates the party (parties) who signed has (have) read the terms and conditions carefully and understand(s) their significance.

<WorldClassNet> - Terms and Conditions

I. ACCEPTABLE USE: The purpose of the Internet is to support research and education in and among academic institutions in the US by providing access to unique resources and the opportunity for collaborative work. The use of your account must be in support of education and research and consistent with the educational objectives of Woodside School District. Use of other organization's networks or computing resources must comply with rules appropriate for that network. Transmission of any material in violation of any US or state organization is prohibited. This includes, but is not limited to: copyrighted material, threatening or obscene material, or material protected by trade secret. Use for commercial activities by for-profit institutions is generally not acceptable. Use for product advertisement or political lobbying is also prohibited. (Initial _____)

II. PRIVILEGES: The use of mail.barrnet.net is a PRIVILEGE, not a right, and inappropriate use will result in a cancellation of those privileges. (Each student who receives an account will be part of a discussion with a WSD faculty member pertaining to the proper use of the network.) The system administrator(s) will deem what is inappropriate use and the decision is final. Also, the system administrator(s) may close an account at any time as required. The administration, teachers and/or staff, of WSD may request the system administrator to deny, revoke, or suspend specific user accounts. (Initials _____)

III. NETIQUETTE (NETWORK ETIQUETTE): The use of an account on mail.barrnet.net requires that you abide by accepted rules of network etiquette. These include, but are not limited to, the following:

1. BE POLITE. Do not send abusive messages to ANYONE.
2. USE APPROPRIATE LANGUAGE. In all messages, do not swear or use vulgarities or any other inappropriate language. Anything pertaining to illegal activities is strictly forbidden.

   (*Note that email is not guaranteed to be private. People who operate the system do have access to all mail. Messages relating to or in support of illegal activities must be reported to appropriate authorities.)
3. PRIVACY. Do not reveal the personal address or phone numbers of yourself or any other person. All communications and information accessible via the network should be assumed private property.
4. CONNECTIVITY. Do not use the network in such a way that would disrupt the use of the network by others.

IV. SERVICES: WSD, Flood, AFdn, etc. will not be responsible for any damages you may suffer. This includes loss of data resulting from delays, non-deliveries, or service interruptions caused by our own negligence or your errors or omissions. Use of any information obtained via mail.barrnet.net is at your own risk. BARRNet specifically denies any responsibility for the accuracy or quality of information obtained through its services.

V. SECURITY: Security on any computer system is a high priority, especially when the system involves many users. If you feel you can identify a security problem on mail.barrnet.net, you must notify a system administrator either in person or via the network. Do not demonstrate the problem to other users. Do not use another individual's account without written permission from that individual. Attempts to login to the system as any other user will result in cancellation of user privileges. Attempts to login to mail.barrnet.net as a system administrator will result in immediate cancellation of user privileges. Any user identified as a security risk or having a history of problems with other computer systems may be denied access to mail.barrnet.net.

VI. VANDALISM: Vandalism will result in cancellation of privileges. This includes, but is not limited to, the uploading or creation of computer viruses.

VII. UPDATES: Woodside School may occasionally require new registration and account information from you to continue providing services. You must notify the technology coordinator of any changes in your account information.
All Terms and Conditions as stated in this document are applicable to the Woodside School District in addition to BARRNet and all other Internet access networks. These Terms and Conditions reflect the entire agreement of the parties and supersedes all prior oral or written agreements and understandings of the parties. These terms and conditions shall be governed and interpreted in accordance with the laws of the State of California, United States of America.
"I understand and will abide by the above Terms and Conditions for an account on the mail.barrnet.net server. I further understand that any violation of the regulations above is unethical and may constitute a criminal offense. Should I commit any violation my access privileges may be revoked, school disciplinary action may be taken and/or appropriate legal action."

USER(S)
SIGNATURE_____DATE____/____/____

Parent or Guardian Network Responsibility Contract

(If user is under the age of 18, a parent or guardian must also read and sign this agreement.)

As the parent or guardian of this student, I have read the Terms and Conditions for mail.barrnet.net. I understand that this access is designed for educational purposes and WSD has taken available precautions to eliminate controversial materials. However, I also recognize it is impossible for WSD to restrict access to all controversial materials and I will not hold them responsible for materials acquired on the network.

Further, I accept full responsibility for supervision if and when my child's use is not in a school setting. I hereby give my permission to issue an account for my child and certify that the information contained on this form is correct.

Parent or Guardian (please print):

_____

Signature:_____
Date: _____/_____/_____

Sponsoring Teacher Contract

I have read the Terms and Conditions and agree to promote this agreement with the student. Because the student may use the network for individual work or in the context of another class, I cannot be held responsible for the student's use of the network. As the sponsoring teacher I do agree to instruct the student on acceptable use of the network and proper network etiquette.

Teacher's Name (please print)

_____

Signature:_____

Date:_____/_____/_____

Internet Etiquette

(Extracted from *An Incomplete Guide to the Internet and Other Telecommunications Opportunities, Especially for Teachers and Students, K–12.* Compiled by the NCSA Education Group, July, 1993.)

"Etiquette" means "ticket" in French. On the Internet, "netiquette" is your ticket to "traveling" (by FTP, TELNET, and electronic mail) without annoying others. Here are few tips to keep you in good standing with other users.

Never Forget That the Person on the Other Side Is Human

Because your interaction with the network is through a computer, it is easy to forget that there are people "out there." Situations arise where emotions erupt into a verbal free-for-all that can lead to hurt feelings. Strongly critical messages on the network are called "flames." The following will help you to avoid sending or provoking flames.

Try not to say anything to others that you would not say to them in person in a room full of people. Please remember that when you send a message to a bulletin board or mailing list, people all over the world are reading your words.

Don't attack people...try to persuade them by presenting facts. Cursing and abuse only make people less willing to help when you need it. If you are upset at something or someone, wait until you have had a chance to calm down and think about it. A cup of coffee or a good night's sleep works wonders on your perspective. Hasty words create more problems than they solve.

Be Careful What You Say About Others

Please remember thousands of people may read your message. They quite possibly include your boss, your friend's boss, your girlfriend's brother's best friend, and one of your father's beer buddies. Information posted on the net can come back to haunt you or the person you are talking about. Think twice before you post personal information about yourself or others.

Be Brief

Say what you have to say succinctly, and it will have a greater impact. Remember that the longer you make your article, the fewer people will bother to read it.

Your Postings Reflect Upon You...Be Proud of Them

Most people will know you only by what you say and how well you say it. Take some time to make sure each posting won't embarrass you later. Minimize your spelling errors and make sure that the article is easy to read and to understand.

Use Descriptive Titles

The subject line of an article enables people to decide whether or not to read your article. Tell people what the article is about before they read it. A title like "Car for Sale" does not help as much as "66 MG Midget for sale: Beaverton OR." Don't expect people to read your article to find out what it's about. Many won't bother. Some sites limit the length of the subject line to forty characters, so keep your subjects short and to the point.

Think About Your Audience

When you post an article, think about the people you are trying to reach. Try to get the most appropriate audience for your message, not the widest. Avoid abbreviations and acronyms, if possible, and define the ones you use. If your message is of interest to a limited geographic area (apartments, car sales, meetings, concerts, etc....), restrict the distribution of the message to your local area. Some areas have special newsgroups with geographical limitations; check with your system administrator. If you want to try a test of something, don't use a world-wide newsgroup! There are newsgroups that are local to your computer or area, which should be used for this. Your system administrator can tell you what they are.

Be Familiar with the Group You are Posting to Before you Post

You shouldn't post to groups you don't read or to groups you've only read a few articles from; you may not be familiar with the conventions and themes of the group. One normally does not join a conversation by just walking up and talking. Instead, you listen first and then join in if you have something pertinent to contribute.

Be Careful with Humor and Sarcasm

Without the voice inflections and body language of personal communications, it's easy for remarks meant to be funny to be misinterpreted. Subtle humor tends to get lost. Take steps to make sure that people realize you are trying to be funny. The net has developed a symbol called the smiley face, which looks like this: :-) It points out sections of articles with humorous intent. No matter how broad the humor or satire, it is safer to remind people that you are being funny. But also be aware that frequently satire is posted without explicit indications. If an article outrages you strongly, ask yourself if it may have been unmarked satire. Several self-proclaimed connoisseurs refuse to use smiley faces, so take heed or you may make a temporary fool of yourself.

Post a Message Only Once

Avoid posting messages to more than one group unless you are sure it is appropriate. If you do post to multiple groups, don't post to each group separately. Instead, specify all the groups on a single message. This reduces network overhead and lets people who subscribe to more than one of those groups see the message once instead of having to wade through each copy.

Please "Rotate" Messages with Questionable Content

Certain messages may be offensive to some people. To make sure that these messages are not read unless they are explicitly requested, they should be encrypted. The

standard encryption method is to rotate each letter by thirteen characters so that an "a" becomes an "n." This is known on the network as "rot13"; when you rotate a message the word "rot13" should be in the "Subject:" line. Most of the software used to read network articles has some way of encrypting and decrypting messages. Your system administrator can tell you how the software on your system works.

Summarize What You are Following Up

When you are following up someone's article, please summarize the parts of the article to which you are responding. This allows readers to appreciate your comments rather than trying to remember what the original article said. It is also possible for your response to reach some sites before the original article does! Summarization is best done by including appropriate quotes from the original article. Don't include the entire article, since it will irritate the people who have already seen it. Even if you are responding to the entire article, summarize only the major points you are discussing.

When Summarizing, Summarize!

When you request information from the network, it is common courtesy to report your findings so that others can benefit as well. The best way of doing this is to take all the responses that you received and edit them into a single article that is posted to the places where you originally posted your question. Take the time to strip headers, combine duplicate information, and write a short summary. Try to credit the information to the people that sent it to you, where possible.

Use Mail; Don't Post a Follow-up

One of the biggest problems we have on the network is that when someone asks a question, many people send out identical answers. When this happens, dozens of identical answers pour through the net. Mail your answer to the person and suggest that they summarize to the network. This way the net will only see a single copy of the answers, no matter how many people answer the question. If you post a question, please remind people to send you the answers by mail and at least offer to summarize them to the network.

Read All Follow-ups and Don't Repeat What Has Been Said

Before you submit a follow-up to a message, read the rest of the messages in the newsgroup to see whether someone has already said what you want to say. If someone has, don't repeat it.

Check the Headers When Following Up

Some software has provisions to specify that follow-ups to an article should go to a specific set of newsgroups; possibly different from the newsgroups to which the original article was posted. Sometimes the groups chosen for follow- ups are inappropriate, especially as a thread of discussion changes with repeated postings. You should carefully check the groups and distributions given in the header and edit them as appropriate. If you change the groups named in the header, or if you direct follow-ups to a particular group, say so in the body of the message; not everyone reads the headers of postings.

Be Careful About Copyrights and Licenses

Once something is posted onto the network, it is probably in the public domain unless you own the appropriate rights (for example, if you wrote it yourself) and you post it with a valid copyright notice. A court would have to decide the specifics, and

there are arguments for both sides of the issue. Now that the US has ratified the Berne convention, the issue is even murkier. For all practical purposes, though, assume that you effectively give up the copyright if you don't put in a notice. Of course, the information becomes public, so you mustn't post trade secrets that way. Keep in mind that material that is UNIX-related may be restricted by the license you or your company signed with AT&T, so be careful not to violate it. You should also be aware that posting movie reviews, song lyrics, or anything else published under a copyright could cause you, your company, or members of the net community to be held liable for damages, so we highly recommend caution in using this material.

Cite Appropriate References

If you are using facts to support a cause, state where they came from. Don't take someone else's ideas and use them as your own. You don't want someone pretending that your ideas are theirs; show them the same respect.

Mark or Rotate Answers and Spoilers

When you post something (like a movie review that discusses a detail of the plot) that might spoil a surprise for other people, please mark your message with a warning so that they can skip the message. Another alternative would be to use the "rot13" protocol to encrypt the message so it cannot be read accidentally. When you post a message with a spoiler in it make sure the word "spoiler" is part of the "Subject:" line.

Spelling Flames Considered Harmful

Every few months a plague descends on the network called the spelling flame. It starts out when someone posts an article correcting the spelling or grammar in some article. The immediate result seems to be for everyone on the net to turn into a sixth grade English teacher and pick apart each other's posting. This is not productive and tends to cause people to get angry with each other. It is important to remember that we all make mistakes, and that there are many users on the net who use English as a second language. There are also a number of people who suffer from dyslexia and who have difficulty noticing their spelling mistakes. If you feel that you must make a comment on the quality of a posting, please do so by mail, not on the network.

Don't Overdo Signatures

Many people can have a signature added to their postings automatically by placing it in a file called "$HOME/.signature". Don't overdo it. Signatures can tell the world something about you, but keep them short. A signature that is longer than the message itself is considered to be in bad taste. The main purpose of a signature is to help people locate you, not to tell your life story. Every signature should include at least your return address relative to a major, known site on the network and a proper domain-format address. Your system administrator can give this to you. Some news posters attempt to enforce a four-line limit on signature files, an amount that should be more than sufficient to provide a return address and attribution.

Limit Line Length and Avoid Control Characters

Try to keep your text in a generic format. Many (if not most) of the people reading Usenet do so from eighty-column terminals or from workstations with eighty-column terminal windows. Try to keep your lines of text to less than eighty-characters for optimal readability. Also realize that there are many, many different forms of terminals in use.

If you enter special control characters in your message, it may result in your message being unreadable on some terminal types. A character sequence that causes reverse video on your screen may result in a keyboard lock and graphics mode on someone else's terminal. You should try to avoid the use of tabs, too, since they may also be interpreted differently on terminals other than your own.

Future Communications Technologies

The technology recommendations in Part III, Chapter 5, A Technical Model, represent the Network Technology Planning Committee's current view of the most cost-effective, reliable network solutions for schools. However, the authors of this report recognize that many newer technologies will become important during this decade; these may become options to consider as the need for greater speed or other functionality arises.

It has been the intention of the Network Technology Planning Committee to recommend well-established, standard technologies within a framework that can be used with newer technologies as well. For example, a school might start with an ethernet network backbone and a leased digital circuit to the school district office. Later, the backbone could be replaced with Fiber Distributed Data Interface (FDDI); the link to the district office might be via a Frame Relay network. In both examples the premise wiring within the school could remain the same. In order to upgrade the network, the fiber for FDDI would need to be added and the network router would need to be replaced. The majority of the wiring and equipment could still be used.

Similarly, if applications were to demand it and sufficient funding were available, all school district and county offices of education could be interconnected with high-speed SMDS service instead of leasing point-to-point circuits to Internet service providers. Internet service then would be provided for all schools by redundant SMDS connections to one or more of the statewide Internet service providers. This would, in effect, provide a physical Golden State Education Network backbone. Again, the only changes from the currently recommended plan would be to replace the network router in the district or county office and acquire a different communication service.

The technologies discussed below do not represent an exhaustive list, nor does this appendix address the costs of these technologies.

I. LAN Technologies

Local Area Network (LAN) technologies interconnect computers within a building or cluster of buildings. The characteristics of LAN technologies are: high speed and relatively short range. Most often LAN data transmission capacity is shared among many computers. Transmission media typically is owned and managed by the school.

A. Fiber Distributed Data Interface (FDDI)

FDDI is an industry standard "token ring" LAN technology that operates at 100 megabits per second. As its name suggests, it was designed to be implemented with fiber optic cabling between connection points and to attached computers. Recent industry standards define how to implement FDDI connections over the type of copper wiring recommended in the Technical Model (Part III, Chapter 5).

FDDI can be used as a backbone for interconnecting a large number of separate ethernet LANs. Many types of computers

can be connected directly to FDDI as well. It is highly recommended that when mixing FDDI and ethernet or other LAN technologies, network routers be used.

Currently many FDDI products are available from a wide variety of vendors. However, it is worth noting that typical costs are still many times higher than those for ethernet.

B. "Fast ethernet"

Industry standards are being developed for ethernet-like LAN technology that will operate at 100 megabits per second. This technology will operate over the type of copper wiring recommended in the Technical Model (Part III, Chapter 5). However, this technology would require replacement of the adapter cards in all attached computers. It is too early to tell whether this technology will become widely available.

C. "Switched ethernet"

A simple way to gain more communications capacity for individual computers on a standard ethernet LAN is to reduce the number of computers attached to the given segment. The ultimate reduction is to a single computer attached to a "switching hub" that will direct ethernet data packets to or from similarly attached computers or ordinary ethernet segments. This could be very effective, for example, for a set of network file servers exchanging data with a small collection of client computers.

Products based on this technology exist, but are very expensive.

D. Asynchronous Transfer Mode (ATM) Backbones

ATM was developed as a communications technology to support digital data transport at many gigabits per second. Recent products support interconnection of FDDI, ethernet, and other LAN technologies through a similar technique. In effect, this provides a very high speed backbone similar in concept to the switched ethernet mentioned above.

In theory, such a backbone could be extended to individual computers and be connected to wide area ATM networks as well. This would allow local and long distance very high-speed connections directly between computers and/or other equipment. The vision of integrated data, voice, and video communications to all network nodes is often predicated on the installation of this technology.

ATM products are beginning to emerge but are extremely expensive. Some futurists predict that a future generation of powerful desktop computers may come with this capability built-in.

E. Wireless LAN Systems

A genre of technology is emerging to support wireless communications to individual desktop or portable computers. The advantages of wireless communications include mobility and inherent extensibility to additional nodes as they appear. The disadvantages include limited range and low speed or significant drain on the batteries in portable computers.

1.) Infrared

Infrared systems are simple to install and relatively inexpensive. The primary disadvantage of Infrared is the requirement for "line of sight" to each computer. In order to protect the integrity of the technology, bright light sources or sunlight must be kept out of view of the receivers (very heavy fog can also cause insurmountable interference). Nonetheless, there are some good applications for infrared (e.g., a portable computer station that must be operated in the middle of an indoor stage or auditorium). Infrared communication speeds range from very low (9600 bits per second) through ethernet speeds.

2.) Radio

Various forms of wireless LAN technologies are emerging. Ethernet-like systems supporting a few dozen nodes are available that will cover areas from a few rooms to several buildings, depending on the construction of the buildings. Generally these systems cost three to five times the cost of standard ethernet.

Low-speed radio data communications is being built in to new portable computers and personal assistant systems such as Apple Computer's Newton product. Typical communications speeds are 9600 bits per second or less.

II. WAN Technologies

Wide Area Network (WAN) technologies are typically used to interconnect LANs or individual computers over long distances. Most WAN technologies are "point-to-point." However, some are actually wide area networks that can transport data among dispersed service points.

Several WAN technologies were mentioned in the recommended Technical Model (Part III, Chapter 5). Those technologies were highlighted because they are the most commonly available and cost effective today. Each school district should explore the costs and availability of all communications services that can transport digital data. New services are being or soon will be offered by a number of carriers including, but not limited to: Pacific Bell, Sprint, and MCI. WAN technologies that may become important to schools include the following:

A. Integrated Services Digital Network (ISDN)

ISDN is a telecommunications standard that provides two (2) 64 kilobit per second "bearer (B) channels" for voice or digital data and one (1) 16 kilobit per second "data (D) channel" primarily intended for communication with the telecommunications switching systems. ISDN can be run over most existing telephone wiring, including to individual homes and offices. ISDN service should be available in all metropolitan areas of California by the end of 1994.

By combining both of the B channels, ISDN could be used to link schools to district offices at 128 kilobits per second. Furthermore, such connections could be "dialed" when needed rather than being live all the time.[1] The cost of this service can be much less than similar "switched 56" or Advanced Digital Network (ADN) leased line service.

ISDN also could be used to link individual computers in homes or small satellite locations to central school LANs. Standard asynchronous speeds up to 38,400 bits per second are supported. This allows "modem-like" serial communications, but at much higher speeds. Synchronous communications at the full B channel speed can be used to achieve the greatest data throughput. However, this usually will require special software and/or hardware.

The cost of ISDN compatible network equipment is still rather high, but costs are expected to significantly decrease as the availability of ISDN service increases the size of the market.

B. Frame Relay Network Service

Frame Relay is a general purpose packet data transport service that can operate at speeds up to at least 1.5 megabits per second. Network routers can connect to this service and establish communications "directly" to any other router in the same service group. As Frame Relay services become available, school districts should explore the costs of this technology compared to traditional point-to-point circuits.

[1] Network equipment can "dial" the number of the remote service port whenever data is available to be sent. If no data arrives within a specified interval, the connection is automatically released.

C. Switched Multimegabit Data Service (SMDS)

Like Frame Relay, SMDS is a general purpose packet data transport service. However, SMDS is designed to operate at speeds from 1.5 megabits per second to several hundred megabits per second. SMDS typically is offered with different "classes of service" that guarantee differing aggregate data volumes. For example, a district might install a 45 megabit per second SMDS service with a "class of service" guaranteeing only 10 megabits per second of average aggregate data traffic. This would cost less than a higher class of service but would still allow occasional full bandwidth data transfers.

SMDS appears to be most cost effective over very wide areas. Within a single county, for example, point-to-point circuits between network routers currently are more cost effective.

D. Asynchronous Transfer Mode (ATM)

ATM is the extremely high speed digital communications technology that underlies SMDS and some of the LAN switching hubs described earlier. In essence, it segments all digital data streams into 48 byte "cells" and transports these cells at gigabit per second speeds to their destinations. Once at their destinations the cells are reassembled. ATM is capable of transporting traditional packet computer data as well as real time digitized voice and video. The use of ATM is the subject of much current network research.

E. Infrared Optical Links

For distances up to 1,000 meters, infrared optical transceivers are available which support communication speeds as high as 10 megabits per second. As with the infrared technology described above (Wireless LAN Systems), the reliability of this technology can be affected by sunlight, bright lights, or very heavy fog. Infrared links are useful for crossing roadways or other land over which the school district may not have a "right of way."

F. Spread Spectrum Radio

As mentioned above (Wireless LAN Systems), radio technology can be used to transport data over modest distances. Spread spectrum is a relatively new technology that uses low power, unlicensed frequency bands for data transmission. For WAN purposes, spread spectrum radio can support up to several megabits per second over ranges of up to five miles. Point-to-point links currently support 256 kilobits per second over a distance of ten miles. It is expected that a wide range of data communication systems using this technology will become available within the next several years.

G. Microwave Radio Links

Traditional microwave radios can be used for distances of approximately twenty miles. Speeds of 45 megabits per second are possible, but the cost of the radios and other components for this capability may be on the order of $200,000. Lower-speed, shorter-range links will cost $15,000 to $40,000.

H. Future Integration of Voice, Data, and Video Communications

It is very likely that emerging technologies will support the transmission of high speed data, voice, and video communications over a common infrastructure. Many researchers and product developers are addressing this goal, but it is too soon to tell which technologies will become important in the school environment.

In the meantime, it is possible today to share bandwidth on high-speed communication "trunk circuits" between locations, a scenario which may prove economical in some situations. For example, part of a 45 megabit/second trunk

circuit could be dedicated to video transmission, another part used for data transmission, and a third part reserved for standard telephone service.

Another approach that is being explored is the use of community cable television (CATV) systems for the distribution of data and even voice services in addition to television programming. Few community systems are designed for this mode of operation today. However many cable operators are interested in the potential. We recommend some caution in commiting to this type of a system without thoroughly understanding its costs and limitations.

A more integrated approach may come from ATM-based communications technologies (see Section II.D. of this chapter, Asynchronous Transfer Mode). ATM can support the isochronous communications required by audio and video, allocating the remaining capacity for packetized data. Theoretically the bandwidth can be allocated dynamically as communications needs change from minute to minute. However, research in this area is still somewhat inconclusive.

III. Conclusions

As stated earlier, the recommendations in this document are made with the expectation that they will allow schools to take advantage of future technologies as they become available. Because of the already huge installed base, both Internet technology and ethernet LAN systems are likely to be well-supported products for at least the remainder of this decade.

Most components installed in the first phase of building the network recommended in this guide can continue to be used as other components are replaced or upgraded. Therefore, overlaying new technologies on top of the recommended infrastructure will require minimal investment and minimal recabling.

By using the technical model suggested in this guide as the framework for your network design, your investments today will be sound and will pave the way to new communications technologies in the future.

Address, Internet = four numbers separated by dots ('dotted quad') which uniquely identifies a computer system connected to the Internet. For example, the Internet address of the Library of Congress' machine that stores texts of legislation is 140.147.254.3. For each address there is a domain name. Either the address or the domain name can be used to access an Internet host for remote login (telnet) or file transfer (ftp). The full domain name of the LC machine is locis.loc.gov.

Address, Email = a combination of an individual username and domain name necessary for electronic messages to be routed to the proper computer system and placed in the proper email box. The two names are separated by an '@'. Note that the user could have a functional name such as 'info' or 'order'. Email to W. Clinton is addressed: president@whitehouse.gov.

ADN = (Advanced Digital Network)

Archie = a search tool for finding network host computers that have programs or data files which can be transferred to your machine. You must know the whole or part of the file name or a string (word or phrase) which might appear in a description of it.

Articles = Messages posted by conferees in Usenet newsgroups. The article beginning a discussion thread is called the base note. Any later article on the same subject is called a response and bears the same subject line in its header. This permits all articles on the same subject to be grouped for easy access by the reader.

ARPANET = See Internet.

Backbone = a high-speed connection within a network that connects shorter, usually slower circuits. NSFNet is the principal backbone for the noncommercial portion of the Internet.

Bandwidth = the capacity of a medium to transmit a signal. More informally, the mythical "size" of a network and its ability to carry the files and messages of those who use it. A faster medium usually measured in bits per second (bps) can send bits more quickly and can accomodate more bits because the faster the bits move the more "space" there is to add others.

BBS = (electronic Bulletin Board System) an announcement and conferencing facility implemented in hundreds of software packages and run on thousands of computers both indivdual and networked. Users accessed early systems via modem and phone line only, though by the mid 80s some BBSs began to network (e.g., Fido BBSs via Fidonet), providing vastly increased resources similar to those of Bitnet and Internet. Most BBS access is still through dialin modems, but some Fidonet conferences (Echos) are carried on Internet. Most individual BBSs now also offer local email and access to databases. See bulletin boards.

Binhex = (binary hexi-decimal conversion) a shareware program for converting Macintosh binary files to text-format (ascii) so that they can be attached to an email message and converted back to binary upon receipt.

BITNET = _Because It's Time Network_ An international educational network which is not a part of Internet but is gatewayed to it so that email can be

exchanged. Listservs, the largest collection of mailists, are hosted on BITNET machines.

Bridge = a device used to expand a LAN by selectively forwarding packets of data to another part of the LAN. It functions as a smart repeater. See Router.

Bulletin boards = Used in networking to refer to a system for providing online announcements, with or without provision for user input. Internet hosts often provide them in addition to Usenet conferences. Sometimes referred to as BBSs. See BBS.

BTW = By The Way; one of a group of abbreviations often used in network messages to save keystrokes; also IMHO = In My Humble Opinion

Client = A software application that works on your behalf to extract some service from a server somewhere on the network. Think of your telephone as a client and the telephone company as a server to get the idea.

CMC = Computer mediated communication; the branch of telecomputing in which users exchange ideas and information by sending email or its variants (e.g., electronic conferencing via newsgroups or mailists or realtime chat—IRC. See Resource Sharing.

Conferencing, Electronic = Any means of discussion among two or more people undertaken via computer and communication media. This includes video conferencing which because of equipment and bandwidth requirements is not yet in wide K–12 use. See Mailists, Newsgroups, BBSs.

Conferencing System = Usually refers to commercial (some are nonprofit, e.g., Institute for Global Communications [IGC]) computer systems which provide CMC and to users who dial in and exchange messages using one-to-one email and many-to-many discussion groups. Some (e.g., Delphi, CompuServe, GEnie, IGC) also provide database resources. They are distinguished from networks by having all or most of their resources on one machine. See Distributed Networking.

CoSN = Consortium for School Networking, a consortium of educational institutions, organizations, corporations, government agencies, and individuals to help K–12 educators and students gain access to information and communication resources. Formed in 1991. Maintains a mailist, COSNDisc, for K–12 educators.

Cyberspace = used by networkers to refer to the vast worldwide reservoir of information being transmitted or stored by internetworked computers. The term was coined by William Gibson in his fantasy novel, *Neuromancer* to describe the world of computers, and the society that gathers around them.

Database, network = any electronically stored and network-accessible collection of information. Network databases include collections of full-text documents, tables, lists, graphics, programs, etc.

Datagram the basic unit of information passed across the Internet. It contains a source and destination address along with data. Large messages are broken down into a sequence of IP datagrams. See packet.

Dialins See Dialups.

Dialups = organizations (usually commercial) which offer Internet access to computers connected via modems to standard voice phone lines. Dialups may be local or national. The latter provide service via public data networks (Tymnet, Sprintnet, etc.) from most population centers or via 800 lines at higher cost. Some people use dialup to refer only to services which give access to computers running special client software (e.g., SLIP, PPP)

containing TCP/IP protocols making the machine an Internet host (with its own Internet address. Services offering access to machines running ordinary terminal emulation programs (e.g., Zterm, Procomm, Flash) are called Dialins. Many dialups/dialins are UNIX systems providing full UNIX funcionality to people with home PCs, Macs, Ataris, Amigas, etc. Generally dialup is used to refer to both types of connection

Distance Learning = in its broader context, distance learning is a term used to describe instruction where teachers are physically or geographically separated from their students. Cable companies, instructional television stations and electronic transmissions via phone lines are all systems that currently deliver distance learning opportunities into the nation's classrooms. More commonly, satellite technology is used to deliver accredited courses where participants watch and interact with the programs via a television set in their school, classroom, or home.

Distributed Networking = dividing up resources among many host computers on a network, thereby reducing the burden on any one system. Distributed networking is a primary characteristic of the Internet. Contrast with conferencing systems.

Distibution list = a group of addresses to which an email message can be sent with a single command. This capability is found in most mail readers and can be used to create an informal mailist.

Domain Name = the name divided by periods (dots) which uniquely identifies a machine on the Internet. The leftmost group of characters is the hostname; the rightmost is the top-level domain—the most general category to which the computer belongs; between these are categories (subdomains) which become narrower as they move to the left. The domain name of the server which houses the CDE gopher is goldmine.cde.gov. Goldmine is the hostname; gov is the top-level domain for government agencies; and cde is the subdomain for the California Department of Education. Large organizations with many hosts in many departments may have domain names with many subdomains.

Domain name server = the computer (or the program) that converts a domain name (as in a telnet address, e.g., locis.loc.gov) to the Internet Address or dotted quad (140.147.254.3 for locis.loc.gov) which the network uses for routing messages. See Address, Internet.

EDUCOM = a consortium of almost six hundred colleges dedicated to the improvement of higher education through the effective and efficient application of information technology.

Email = Electronic mail; Written messages transmitted across networks (or within the same computer) and usually accessible only by the addressee either by using an online mail user agent (mail reader) or by downloading for reading and other processing offline. Each message contains a header with routing, date and subject information, and a body containing the messsage. Email is the essential CMC one-to-one or one-to-few vehicle. Compared to paper mail email is faster, requires less effort once the system is booted up and connected to the network, permits group planning and organizing because of easy and rapid response, but is less secure.

Distribution list = a group of addresses to which an email message can be sent with a single command. This capability is found in most mail readers and can be used to create an informal mailist.

ERIC = the Educational Resources Information Center is a federally funded national information system that pro-

vides access to an extensive body of education-related literature and bibliography. ERIC provides access via email query, gopher server, telnet sites, and anonymous ftp sites.

Ethernet = a 10-million bits per second networking design originally developed by Xerox Corporation that is widely used for LANs because it can network a wide variety of computer types, is not proprietary, and uses components that are widely available from many sources.

FAQ = Frequently Asked Questions, a compilation of the most often asked questions and answers on the topic covered by the newsgroup which maintains and updates the FAQ. Search the FAQ before posting a question on the newsgroup or related mailist.

FDDI = (Fiber Distributed Data Interface) a new standard for network technology using fiber optic cable capable of 100-million bit per second data rate.

Finger = a command (and the program) used to locate people on a given machine and to access limited information stored in fingerable files. (Weather data is currently supplied through this mechanism.) Machines running finger daemons allow remote access to their finger program.

Flame = an email, newsgroup, or mailist message which is vigorously argumentative and often ad hominum. Flaming, except in newsgroups designed for that purpose, is discouraged on the Internet.

Frame Relay = a CCITT recommendation (I.122) and ANSII standard (T1S1). Frame relay is an ISDN (Integrated Services Digital Network) packet-mode bearer service that defines a user-to-network interface. The two main benefits are bandwidth on demand and integrated access. The standard currently addresses data communications speeds up to 2 Mbps over permanent virtual circuits. By reducing the network functions performed, frame relay takes advantage of more robust physical facilities to improve throughput.

FTP = (File Transfer Protocol), the command (and process) for moving files or programs across the Internet from a remote server to your own host, (analogous to Xmodem or Kermit for transfers across voice phone lines between computers using terminal emulation software.). Systems set up to offer open public access to their resources (anonymous ftp) will admit remote users who login, with the ID 'anonymous'. If you connect to your Internet host via terminal emulation software you must use Xmodem, Zmodem, Kermit, etc., to complete the transfer to your machine.)

Gateway = a special-purpose dedicated computer that is a node in two (or more) networks and routes packets from one network to the other. The two networks may use the same protocol or different protocols. The gateway has a name/address in EACH network and has to be running an implementation of each protocol. An Internet gateway (both nets are using the TCP/IP protocol) routes IP datagrams between the networks it connects. Gateways route packets to other gateways until they can be delivered to the final destination directly across one physical network.

Gopher = software which permits searching files on remote hosts using layered menus. Text from these files can be read online or the files can be transferred to your computer.

Header = the portion of a packet, preceding the actual data, containing source and destination addresses and error-checking fields. Also the part of an email message or news article which includes information normally found in the letterhead, date, inside address,

and subject line of a business letter, as well as other routing data.

Host = any computer (node) connected to a network which is directly used by resources (e.g., public domain programs, text/data files, mailboxes). An Internet host can be identified by its dotted quad address or its distinctive domain name.

Hub = a regional point of connection between an Internet user and the Internet. Regional hubs are also called Internet Service Providers which sell their networking services for a fee. (See Internet Service Provider below.)

Hytelnet = a hypertext menuing system to locate remote resources.

IETF = Internet Engineering Task force, an open body of Inet users, vendors, and developers who develop Inet standards.

IMHO = In My Humble Opinion, abbreviation often used in net messages; seldom humble. See BTW.

Information Infrastructure = the aggregate of computers, computer data banks, fax machines, telephones, and video displays and their high-speed telecommunication links. Also included, though less often mentioned, are the equipment manufacturers, training institutions, legal and regulatory systems, and other institutions and structures which contribute to the creation, processing, and transmission of information.

Internet = the Internet, with definite article and capital I, is a set of networks all running the TCP/IP protocols, sharing the same underlying network address space as well as the same domain name space, and interconnected into an internet. The Internet dates from 1983, called before that, the ARPA Internet, which grew out of a Department of Defense (DoD) experiment in1968 to test the sharing of expensive computer facilities which DoD-funded researchers were demanding at sites around the country. In 1983, Milnet, the military production network separated from ARPANET, and reflecting increased non-military research needs, NSF was given responsibility for supervision of the resulting structure, named the Internet. NSFnet, is the highspeed backbone to which most universities and other research facilities were connected via regional internetworks. See also NREN.

internet = (with a little i) or internetwork can be any old internet which interconnects other networks, such as the XEROX Internet. There are also other TCP/IP internets.

Internet Service Provider = also known as ISP, this can be any business or enterprise that acts as a middleman between the Internet and the connecting individual or agency. ISP's are usually geographically close to the connecting site and could vary from a commercial organization to a university. The ISP will assign the user an Internet "address" attaching their own domain name to the end of the code. It is this address which enables a user to receive mail.

Internet Tour = a Mac, full color, Hypercard guide (Often called the MERIT Tour) to the high spots of the Internet.

Interoperability = the capacity of multivendor computers to work together using a common set of protocols. When interoperable, PCs, Macs, Suns, Dec VAXen, CDCCybers, etc, all work together allowing one host computer to communicate with and take advantage of the resources of another. The TCP/IP+ protocols are a major implementor of interoperability.

IRC = Internet Relay Chat, an Internet service permitting real-time messaging similar to a CB system but in written form.

ISDN = Integrated Services Digital Network: design specifications for digital transmission on existing copper phone lines. Advocated by the long distance phone carriers as a cheaper alternative to fiber optic lines.

Keypals = the electronic equivalent of penpals.

Knowbots = dynamic programs that move around in networks and carry out algorithms or searches. While the knowbot is carrying out a search, it can modify it, for example, by searching another database.

LAN = Local Area Network; a network spanning a small area, usually a building or set of buildings, and usually using high-speed but low-cost media, and owned by the user organization

Listservs See Mailists.

Login = to enter a network or computer. As a noun, login is a synonym for a user's network account name or userid, a word composed of alpha and/or numeric characters that uniquely identifies each user of a network. Access to particular network host may also require a login which may not be unique but enables the computer to identify the files or program to which the user will have access. For example, the login, gopher, on a host to which the user has telnetted may connect to a public gopher client running on that host.

Mailists = a conference/discussion group in which all messages are sent to one email address from which they are redistributed to the email boxes of everyone who has subscribed. All messages are expected to pertain to a specific topic. If moderated, messages will be reviewed before distribution. A more convenient discussion vehicle than newsgroups, but one which can easily result in email box overload (many-to-many CMC).

Mail Reader (or Mail User Agent) = software on the the user's network host computer which organizes the incoming email data so that it can be sorted and displayed and manipulated (printed, forwarded, replied to, saved to a file, deleted, etc.). An offline reader or browser is software that runs on the user's own machine, which downloads the current email messages, permitting them to be read and answered while not logged on to the network. Note that the user's own machine may be connected to a LAN or may be at a remote site logging in via telephone dialup.

Matrix, The = a worldwide community of cyberspace communicators composed of the Internet and a myriad of other WANs and internets (e.g., BITNET, UUCP, and JANET); commercial Conferencing Systems; and networked BBSs (e.g., FidoNet); all of which are connected for email exchange only, (because they do not share the TCP/IP protocols). (See _The Matrix_ by John Quarterman, Digital Press, 1990)

Modem = a device which connects between a computer and a phone line to translate between the digital signal of the computer and the analog signal required for telephone transmission. A net modem connects the hosts on a LAN with a phone line (also Modem Pool)

MUD = (Multi-User Dungeon [or Dimension]) a text-based simulation of reality derived from the early single user text adventure games and Dungeons and Dragons board games. Users navigate through rooms, manipulate objects and interact with other users. MUDs (and their variants, MUSHes, tinyMUDs, etc.) can range from time (and bandwidth) wasting to intellectually challenging and skill building.

Multiplex = the division of a single transmission medium into multiple logical channels supporting many simultaneous sessions. For example, one network may have simultaneous FTP,

telnet, and SMTP (mail) connections, through one set of wires.

Netiquette = the informal rules of behavior while communicating or resource sharing on the Internet.

Network = a set of computers communicating over communication media (e.g., telephone, radio, cable) using common conventions called protocols. Networks are used for CMC and resource sharing. A network is a real entity with a name, history, administration, financing and addressing/routing scheme in addition to the protocol. Network also may refer to a group of people with a common interest who use part of a network or internetwork to communicate and share information on one or more subjects.

Network application gateway = see gateway.

Newsgroups = Electronic conferences/discussion groups similar to mailists. Newsgroup messages, called articles, are not mailed to a subscriber's email-box but are distributed to a subscribing system's news server. This single copy is then accessed by all users on their network-connected machines. There are over 2500 active newsgroups. Each newsgroup focuses on a subject area (e.g., soc.culture.china—highest level subject: social issues; intermed. level subject: culture; low level subject: China.) Within each newsgroup specific discussion threads are identified by common subject lines in the header of each message. See Article and Usenet.

NIC = Network Information Center

NOC = Network Operations Center

Node = any computer, machine, system, connected to a network.

Novell = A software company that was started in 1983. Their objective was to develop a network operating system (NOS) that would allow micro-computers to share resources and data. They have since grown to be the largest NOS vendor in the world. They provide a framew ork of tools, information and support that can create a network solution, from a small workgroup network to an enterprise-wide network system.

NREN = National Research and Education Network, which will replace the current non-commercial part of the Internet. Created by High Performance Computing Act of 1991, Public Law 102-194, a framework for coordinating and improving the networking programs of agencies of the Federal Government, a program for engineering and deploying billion-bit-per-second and higher performance networks, and a process for formulating and evaluating public policy. Although not a part of the original NREN plan, provision has been made for including K–12 schools, libraries and other community institutions in the development process.

NSFnet = National Science Foundation Network; a backbone or major link of the Internet and an internet in itself; serves research and education activities; non-commercial.

OPAC = Online Public Access Catalog The contemporary electronic version of the old library card catalog. Hundreds are currently connected to the Internet including the Library of Congress OPAC, permitting extensive bibliographical research from any Intenet connected computer.

Packet = The unit of data sent across a packet-switching network. The term is used loosely. While some Internet literature uses it to refer specifically to data sent across a physical network, other literature views the Internet as a packet switching network and describes IP datagrams as packets. Protocol = A set of software rules which governs one or more aspects of the

communication between networked computers. See TCP/IP.

Packet Switching = using a packet-switched network means you have no dedicated piece of a circuit. What you send is mixed together with everyone else's transmissions, similar to the U.S. Postal Service moving a bag of letters. Because of the address encoded in each unit of mail, your message reaches its destination along with all the others, sometimes taking different routes to get there depending upon the traffic at the time of transmission.

PC = Personal Computer, used in this document to refer to DOS or Windows-based machines

PINE = An email package developed by University of Washington.

PPP = Point to Point Protocol; a protocol that allows a computer to use the TCP/IP (Internet) protocols (and become a full-fledged Internet member) with a standard telephone line and a high-speed modem. PPP is a new standard for this which replaces SLIP. Although PPP is less common than SLIP, it's quickly increasing in popularity.

RFC = (Request for Comments) An official Internet online document which specifies standards or provides extensive information about Internet activities or structures.

Repeater = A device connected into a network to amplify or otherwise condition signals and pass all of them on to another part of the transmission medium without altering the addresses or data. A repeater may be required to expand a LAN. See Bridge; Router.

Resource Sharing = a function of networks and many conferencing systems in which users access remote computer systems: 1) to read documents or up/download documents or program files or 2) to use the computing or peripheral resources on the remote machine.

Router = a device (sometimes a dedicated computer) within a network that forwards packets of data of a specific protocol type (such as IP) from one network to another. It processes the data to determine how to forward packets toward their destination.

Server = a computer which offers services to another computer; also the software which enables it to do so. The computer served is a client which runs client software to obtain the services. The workload involved in providing the service is thus divided between the server and the client. Telnet, ftp, and gopher are client programs which request services from remote servers.

Signature = A block of information about the sender which netiquette dictates should appear at the end of an email message because the From: address in the header rarely fully identifies the sender. Should be kept to three or four lines which can often be automatically appended by creating a sig.file on the sender's system.

SLIP = Serial Line Internet Protocol; a protocol that allows a computer to use the Internet protocols (and become a full-fleged Internet member) with a standard telephone line and a high-speed modem. SLIP is being superseded by PPP, but is still in common use.

Smilies = combinations of keyboard characters which enable electronic correspondents to convey non-verbal cues. Hundreds are currently known. If used to excess they can result in diminished enthusiasm (and stiff necks) among readers. :-) <—standard smile But they can help some people understand which of multiple possible meanings was intended. ;-) <—wry smile (or leer)

SMDS = Switched Multimegabit Data Service. An emerging high-speed networking technology to be offered by the telephone companies in the U.S.

SMTP = (Simple Mail Transfer Protocol) The Internet standard protocol for transferring electronic mail messages

from one computer to another. SMTP specifies how two mail systems will interact and the format of control messages they exchange when transferring mail.

SNMP = (Simple Network Management Protocol) The network protocol that permits monitoring and management of the operations of LANs and internetworks and their hosts, servers, etc.

Snailmail = Networkers' disparaging term for paper-based mail.

Switched 56 = See ADN.

TCP/IP = (Transmission Control Protocol/Internet Protocol) The sets of software rules which enable computers to directly connect to networks which are interconnected through the Internet. Though designed for UNIX systems, TCP/IP software is now available for computers running operating systems other than UNIX.

Telecommunications = long-distance communications using electromagnetic systems-including wire (e.g., telephone or telegraph) and broadcast transmission (e.g., radio, television, or satellite). It is often used by computerists to refer to CMC and resource-sharing activities using either conferencing systems or networks. See Telecomputing.

Telecomputing = a shorter term for computer-based telecommunications; sometimes used to refer specifically to use of the computing resources of a remote system, as in computer time sharing.

Telenet = a public data network (PDN) which permits users to dial a local exchange and be connected to remote conferencing systems and Internet dialups. (New name = Sprintnet) Don't confuse with telnet.

Telnet = the TCP/IP command (and the program) used to login to remote host computers and read text or other data from their files and otherwise use the host as if seated at a terminal at the remote site. Usually the user must have an account and log into the remote host with a name and password. Many systems allow public access without accounts. Some require no login ID; others require a login ID, which must be known in advance.

TERC = Technology Education Research Center, Cambridge MA; a nonprofit institution heavily involved in research and development of telecomputing.

Terminal = a keyboard with display which has limited processing circuitry and therefore relies on the remote computer to which it is connected for everything but input and output of data. Microcomputers which cannot connect directly as nodes to LANs or WANs may connect through a terminal server by running software which emulates a standard terminal such as a VT100. A VT100 terminal or VT100 terminal emulation software (or better) is required to use many of the services on the Internet.

Terminal server = a specialized, networked computer (or the software) that connects terminals (or computers functioning as terminals) to a LAN through one network connection. Any user so connected can then connect to other network hosts. Use of these hosts is then limited by the type of terminal or, if the machine is a computer, by the terminal emulation software the computer is running. See terminal.

Thick/thin-net ethernet = The original 10 megabit per second ethernet standard specified a special double shielded coaxial cable. The cable is approximately 1/2" diameter and very stiff. The electrical properties of this cable allow a single segment to be as long as 500 meters which makes it a reasonable choice for interconnecting buildings or creating modest backbone distribution facilities. Subsequently, standards were developed to allow use of smallerRG58 coaxial cable, but the

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This publication is one of over 600 that are available from the California Department of Education. Some of the more recent publications or those most widely used are the following:

Item no.	Title (Date of publication)	Price
1151	Adoption Recommendations of the Curriculum Development and Supplemental Materials Commission, 1994: Follow-up Adoption, Science (1994)	$5.50
0973	The American Indian: Yesterday, Today, and Tomorrow (1991)	6.50
1079	Beyond Retention: A Study of Retention Rates, Practices, and Successful Alternatives in California (1993)	4.25
1067	California Private School Directory, 1993-94 (1993)	16.00
1086	California Public Education: A Decade After *A Nation at Risk* (1993)	4.75
1091	California Public School Directory (1994)	16.00
1036	California Strategic Plan for Parental Involvement in Education (1992)	5.75
0488	Caught in the Middle: Educational Reform for Young Adolescents in California Public Schools (1987)	6.75
1072	Commodity Administrative Manual (1993)	13.00
0978	Course Models for the History–Social Science Framework, Grade Five—United States History and Geography: Making a New Nation (1991)	8.50
1034	Course Models for the History–Social Science Framework, Grade Six—World History and Geography: Ancient Civilizations (1993)	9.50
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1098	English as a Second Language: Implementing Effective Adult Education Programs (1993)	6.00
1046	English-as-a-Second-Language Model Standards for Adult Education Programs (1992)	7.00
0041	English–Language Arts Framework for California Public Schools (1987)	5.00
0927	English–Language Arts Model Curriculum Standards: Grades Nine Through Twelve (1991)	6.00
1124	Exemplary Program Standards for Child Development Programs Serving Preschool and School-Age Children (Spanish) (1994)	5.50
0804	Foreign Language Framework for California Public Schools (1989)	6.50
1116	The Framework in Focus: Answers to Key Questions About the English–Language Arts Framework (1993)	5.50
1089	Greatest Hits in Environmental Education (1993)	7.00
1083	Handbook for Teaching Vietnamese-Speaking Students (1994)*	5.50
1064	Health Framework for California Public Schools, Kindergarten Through Grade Twelve (1994)	8.50
0734	Here They Come: Ready or Not—Report of the School Readiness Task Force (Full Report) (1988)	5.50
0712	History–Social Science Framework for California Public Schools (1988)	7.75
1154	Home Economics Education Career Path Guide and Model Curriculum Standards (1994)	17.00
1114	Implementation of Middle Grade Reforms in California Public Schools (1993)	6.50
1071	Independent Study Operations Manual (1993)	30.00
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